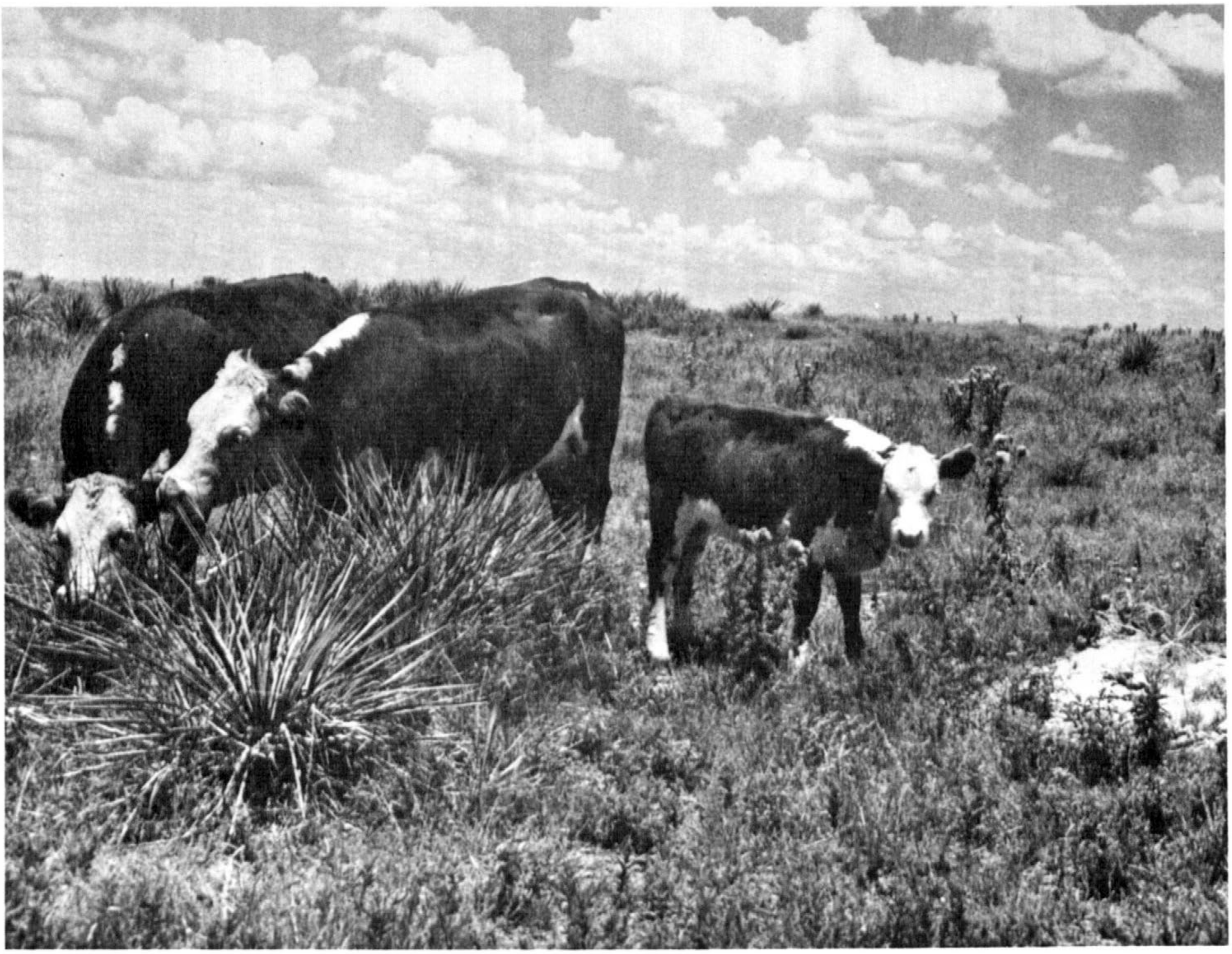
SOIL SURVEY

Randall County, Texas



UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
in cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1955–64. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1964. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station; it is part of the technical assistance furnished to the Palo Duro Soil and Water Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or can be purchased, on individual order, from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Randall County, Texas, contains information that can be applied in managing farms, ranches, and grazing lands; in selecting sites for roads, ponds, buildings, or other structures; and in judging the suitability of tracts of land for agriculture, industry, or recreation.

Locating Soils

All of the soils of Randall County are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, range site, or any other group in which the soil has been placed. Interpretations not included in the text can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the discussions of the capability units and range sites.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Use of the Soils for Wildlife."

Ranchers and others interested in range can find, under "Range Management," groupings of the soils according to their suitability for range and also the plants that grow on each range site.

Community planners and others concerned with suburban development can read about the soil properties that affect the choice of homesites and other building sites in the section "Use of Soils in Community Development."

Engineers and builders will find under "Engineering Uses of Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Randall County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About the County."

Cover picture—Cow-calf type of ranching in the county. The soil is Mobeetie fine sandy loam.

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Issued June 1970

SOIL SURVEY OF RANDALL COUNTY, TEXAS

BY LOUIS JACQUOT, LUTHER C. GEIGER, BILLY R. CHANCE, AND WILBUR TRIPP,
SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH TEXAS AGRICULTURAL EXPERIMENT STATION

RANDALL COUNTY, in the southern part of the Great Plains (fig. 1), has a total area of 920 square miles, or 588,800 acres. It is one of the south-central counties of the Texas Panhandle. About 85 percent of the county consists of smooth areas of the High Plains, and about 15 percent is rough land of the canyons and valleys of the Palo Duro Creek and its tributaries that drain into the Prairie Dog Town Fork of the Red River.

The past growth of the county depended almost entirely on products of agriculture. About 63 percent of the land area is cropland, of which about three-fourths is dryfarmed and one-fourth is irrigated. The major crops are dryland and irrigated winter wheat and sorghums, though some cotton is grown in the southern part of the county. Most of the rangeland is grazed by beef cattle, and some areas are grazed by dairy cattle and sheep.

Cropland and rangeland generally conform to the relief of the smooth High Plains and the rough lands of the county. Practically all of the cropland is in the High Plains part of the county. This includes all of the county except the rough land along the Palo Duro Creek and its tributaries. This drainage system bisects the county, flows in an easterly direction, and enters the Prairie Dog Town Fork of the Red River east of the Randall-Armstrong County line.

The High Plains is a nearly level, treeless plain that is part of a vast apron of material that was washed from the Rocky Mountains, mainly during the Pliocene epoch. This material, known as the Ogallala formation, was later mantled with eolian and loessal sediments that formed the present smooth, gradually sloping plain.

The High Plains part of the county is marked by a prominent escarpment where it borders the Palo Duro Canyon and its tributary canyons. Elevation of the High Plains ranges from 3,460 to 3,890 feet. Except where pitted by playas, the surface is remarkably smooth. These playas range from a few square yards to 9 square miles in size and from a few inches to more than 50 feet in depth. The average grade of the High Plains is about 10 feet per mile to the east. Runoff follows a poorly defined pattern. Runoff water flows into the depressions or playas, from which there is no definite outlet. When a small playa fills, any additional water must drain into another larger playa where the elevation is lower. Overflow from the playas furnishes the water for the Palo Duro and Tierra Blanca Creeks in Deaf Smith County and for Cita and other creeks within Randall County.

Most soils of the High Plains are uniform, deep fine sandy loams to clay loams, and in most places, natural fertility is high. Minor soils are those in large depressions, or playas; soils on bottom lands of valleys and canyons; and scattered areas of limy soils on the High Plains or bordering them. On the High Plains, the native vegetation was a dense growth of short grasses, chiefly consisting of blue grama and buffalograss. Some needlegrass and sideoats grama commonly grow on the limy soils.

Geologic erosion in the rough land that once was part of the High Plains, known as the Palo Duro Canyon and valleys, has formed a rough landscape, of which the front is the beginning of the Rolling Plains. Streams generally flow to the east in a dendritic, or branching pattern. Stream erosion and some soil blowing have formed the Palo Duro Canyon, a rugged, much dissected area fronted by escarpments of caliche and sandstone that are not accessible to livestock in places. Along the canyon, elevation ranges from about 2,700 to 3,460 feet.

From the Palo Duro, Little Sunday, and Timber Creeks, stream erosion has brought up material of three geologic eras: (1) the High Plains deposit of Cenozoic era; (2)

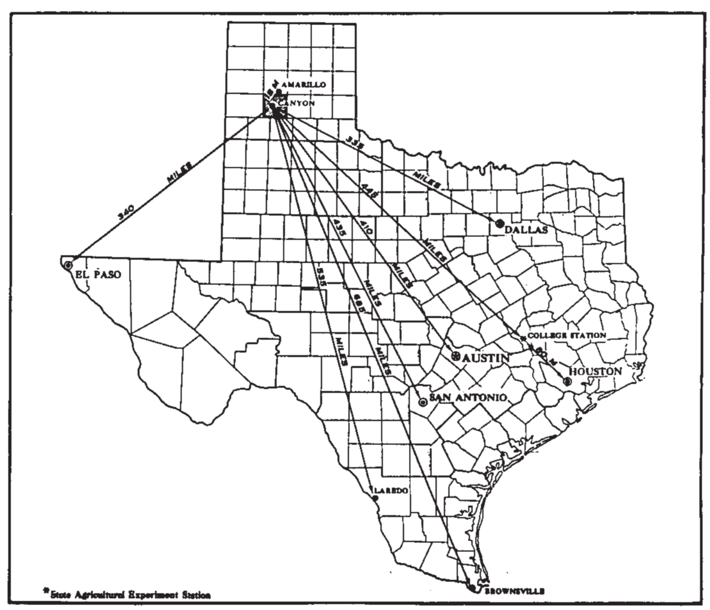

Figure 1.—**Location of Randall County in Texas.**

the colorful Triassic deposits of the Mesozoic era; and finally, (3) the oldest deposits of Permian material laid down in an inland sea in the Late Paleozoic era.

Soils of the Palo Duro Canyon are mostly shallow to very shallow, and in places rock is near the surface. A narrow band of alluvium of variable depth has been laid down by the Palo Duro Creek and its tributaries. In Palo Duro Canyon, growth of mostly black grama, blue grama, little bluestem, and various forbs is sparse to good. Shrubs and juniper trees are commonly scattered throughout most of the canyon, and cottonwood trees border the streambeds.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Randall County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they already had seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped.

Pullman and Amarillo, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Amarillo fine sandy loam is a soil type in the Amarillo series.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Amarillo fine sandy loam, 1 to 3 percent slopes, is one of several phases of Amarillo fine sandy loam, a soil type that ranges from nearly level to gently sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed and so small in size that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Kimbrough-Lea loams. Most surveys include areas where the soil material is so rocky, so shallow, or so frequently worked by wind and water that it cannot be classified by soil series. These areas are shown on the map like other mapping units, but are given descriptive names, such as Broken alluvial land, and are called land types.

The soil scientist may also show as one mapping unit two or more soils that are mapped as one unit because their differences are not significant for the purpose of the survey. Such a mapping unit is called an undifferentiated soil group. An example is Drake soils, 1 to 3 percent slopes.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil surveys. On the basis of the yield and practice tables and other data, the soil scientists set up trial groups, and then test them by further study and by consultation with farmers, agronomists, engineers, and others. The scientists then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this publication shows, in color, the soil associations in Randall County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, or choosing the site for a building or other structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

Randall County has seven soil associations, parts of six of which are shown in figure 2. All of the associations in the county are described in the following pages.

1. Pullman Association

Nearly level to gently sloping, deep soils that have a loamy surface layer and a firm clay subsoil

The soils of this association are nearly level to gently sloping, and they occupy broad uplands, mostly in the northern and southern parts of the county. The association covers about 72 percent of the county and is a smooth, featureless plain that is dotted by many saucer-shaped depressions, or playa lakes (fig. 3). These playas catch most of the runoff from heavy rains and also irrigation tail water. The soils in this association formed in material deposited by wind on the High Plains. The native vegetation was mid and short grasses.

The Pullman soils make up about 80 percent of this association. Minor soils occupy the remaining 20 percent.

Pullman soils are on the higher lying, broad upland plains. They have a dark grayish-brown, neutral clay loam surface layer about 6 inches thick. The upper part of the subsoil is dark grayish-brown to brown, very firm clay about 46 inches thick. Reaction grades from neutral at the top of this layer to alkaline at the bottom. The lower part of the subsoil is reddish-brown heavy clay loam. At a depth of 62 inches is pink clay loam that contains many concretions of lime.

The minor soils in this association are in the Randall, Roscoe, Lofton, Ulysses, Zita, Mansker, and Drake series. They are near the playa lakes. The Randall and Lofton soils are the most extensive. The Randall soils are poorly drained and are on the floor of playas, a few feet below the Roscoe, Lofton, and Zita soils. The Ulysses, Mansker, and Drake soils occupy the more sloping upper rim of the playas.

The soils in this association are suitable for cultivation, but use is limited mainly by low rainfall. Most of the acreage is dryfarmed to winter wheat and grain sorghum. Where water is available for irrigation, alfalfa, cotton, sugar beets, and corn for silage are also grown. The remaining acreage is used for native range. The many lakes in this association are suitable for development into wildlife areas for ducks and geese.

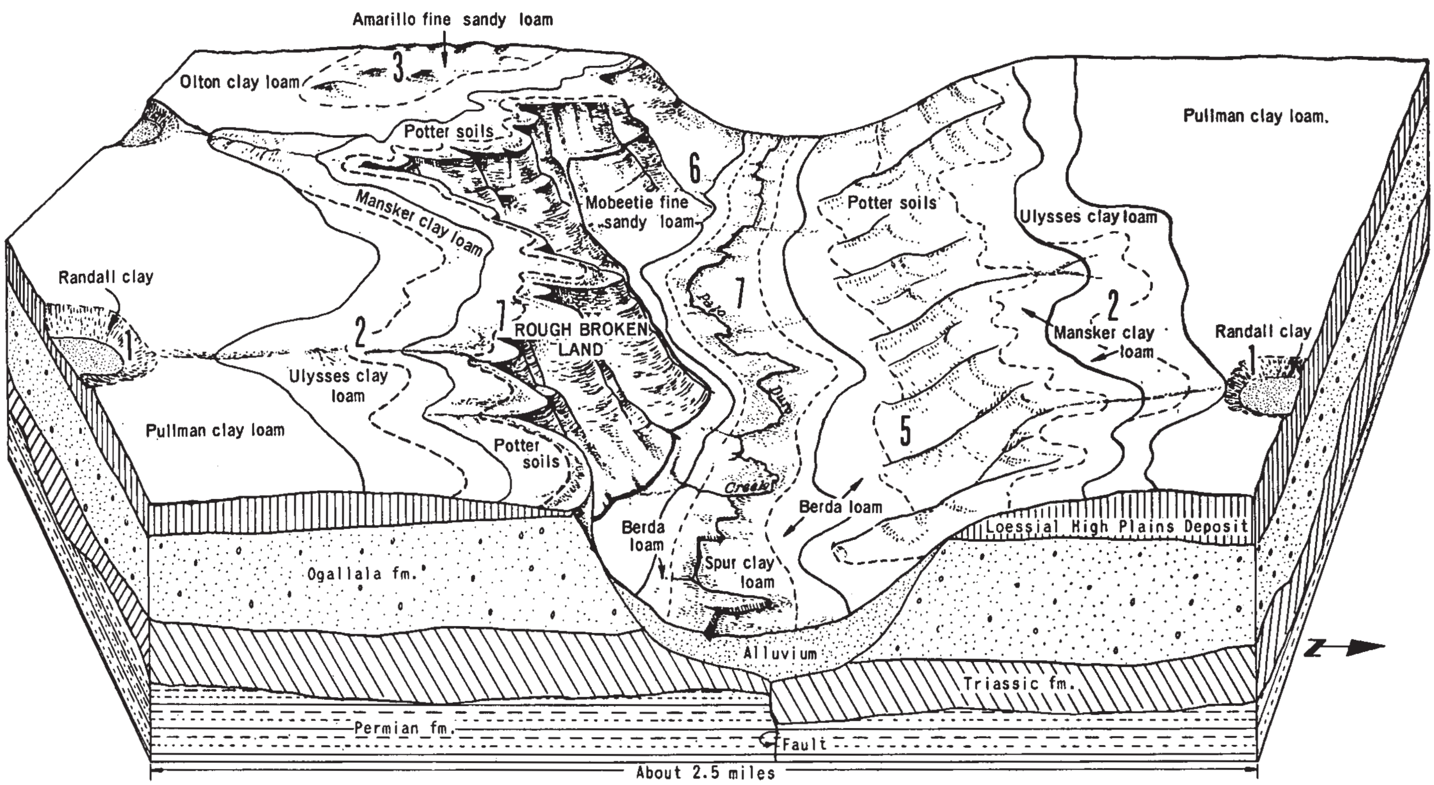

Figure 2.—**Parts of six of the seven associations in Randall County are along Palo Duro Creek and the surrounding tableland on the High Plains. Unbroken lines are boundaries between soil associations: broken lines are boundaries between soils.**

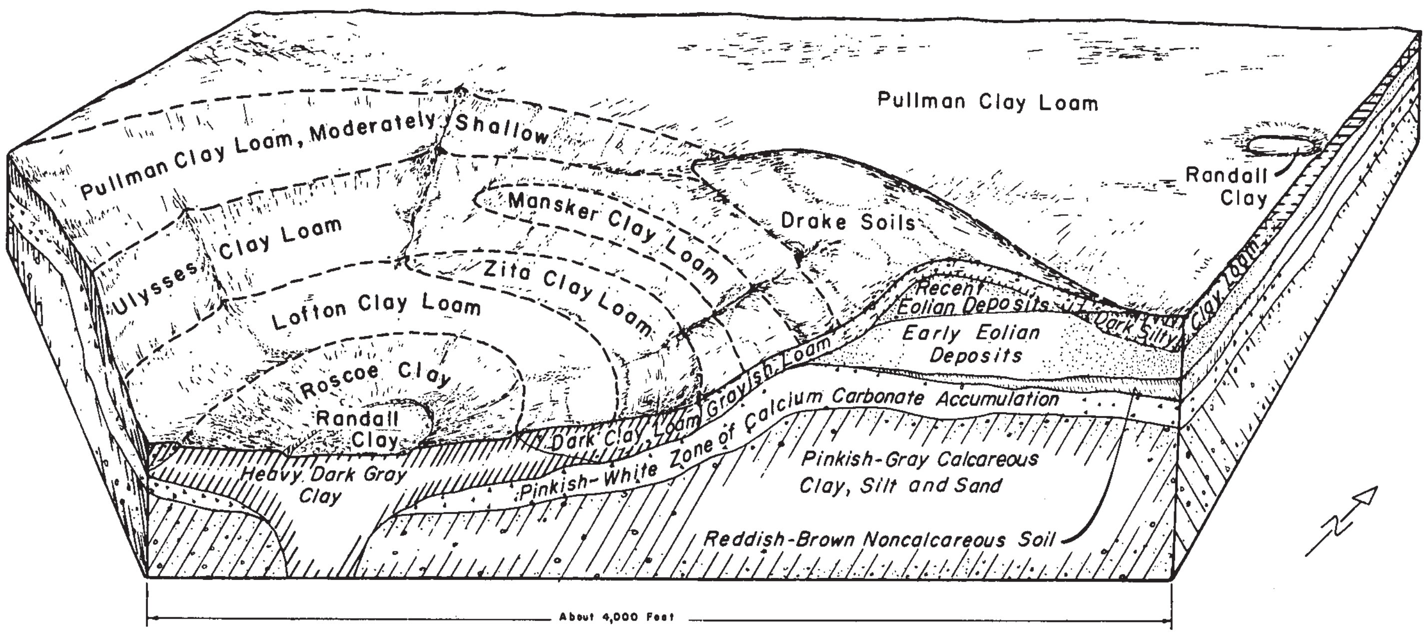

***Figure 3.*—Pattern of soils that is typical around the playas in soil association 1.**

2. Ulysses-Mansker Association

Nearly level to moderately sloping, loamy soils that are shallow and moderately deep over caliche

The soils of this association are nearly level to moderately sloping. They occupy divides and side slopes of drainageways in the northwestern quarter of the county and in a large area surrounding Buffalo Lake. This association covers about 8 percent of the county.

Ulysses soils make up about 62 percent of this association; Mansker soils, about 28 percent; and minor soils, the remaining 10 percent.

The Ulysses soils occupy the higher lying areas of this association and are nearly level to gently sloping. These soils have a grayish-brown, calcareous clay loam surface layer about 8 inches thick. It is underlain by brown clay loam that extends to a depth of 30 inches. This layer has been highly worked by earthworms. It is underlain by a layer of lime accumulation.

Mansker soils are gently sloping to moderately sloping, and they occur in areas that grade to drainageways. These soils have a brown, calcareous, crumbly clay loam surface layer about 9 inches thick. It is underlain by brown clay loam that extends to a depth of about 19 inches. Concretions cemented by lime are common in this layer. The next layer consists of pinkish-white clay loam and concretions of lime. These concretions make up about 45 percent of the layer by volume.

The minor soils are in the Potter, Kimbrough, and Drake series. The Potter and Kimbrough soils are adjacent to escarpments and are very shallow. The Drake soils commonly occur on the east and southeast sides of Buffalo Lake and the larger playas.

About 60 percent of this association is farmed, and the remaining acreage is native range. The soils in this association are fairly suitable as cropland and are well suited as range. Small grains, grain sorghum, and cotton are the principal crops. About 15 percent of the cropland is irrigated. Soil blowing and water erosion are constant hazards in cropped areas.

3. Olton-Amarillo Association

Nearly level to moderately sloping, deep soils that have a loamy surface layer and subsoil

The soils of this association are nearly level to moderately sloping. They occur mostly as broad, undulating divides and extensive flats between Buffalo Lake and Palo Duro State Park. The flats are nearly level, but they contain rises and ridges that generally extend in a northeast-southwest direction and are about 3 to 30 feet above the level of the surrounding plain. The ridges consist of old subdued dunes that probably were formed from deposits blown from the Umbarger and Canyon Basins. This association covers about 7 percent of the county.

Olton soils make up about 62 percent of this asociation; Amarillo soils, about 18 percent; and minor soils, the remaining 20 percent.

Olton soils are nearly level on the smooth tableland and are gently sloping to moderately sloping on the divides. They have a dark-brown, neutral clay loam surface layer about 8 inches thick. The subsoil is dark-brown to reddish-brown clay loam about 40 inches thick. Reaction grades from neutral at the top of this layer to calcareous in the lower part. The underlying material is pinkish-white caliche. The Amarillo soils are on flats, divides, and rises or subdued dunes above the flats. Their surface layer is brown, neutral fine sandy loam about 11 inches thick. The subsoil is reddish-brown to yellowish-red, crumbly sandy clay loam about 27 inches thick. It is underlain by pink caliche of about sandy clay loam texture.

In this association the minor soils are in the Acuff, Zita, and Ulysses series. Acuff soils, like the Olton, are on smooth tableland and sloping divides. The Zita and Ulysses soils are near playas.

About 40 percent of this association is used for crops, and the rest is in native range, which is a good use. Short and mid grasses are dominant in the native vegetation. A few fields are irrigated. Sorghums and winter wheat are the principal crops in dryfarmed areas, but some cotton is also grown. Soil blowing is a hazard in cropped areas. In sloping areas water erosion is troublesome.

4. Rough Broken Land-Potter-Quinlan-Woodward Association

Rough broken land and dissected, loamy soils that are very shallow to moderately deep over caliche, sandstone, or siltstone

This association consists mainly of Rough broken land and severely dissected soils in the Palo Duro and Cita Canyons in the eastern part of the county. The soils are very shallow to moderately deep. The association is characterized by steep to vertical canyon walls, raw gorges, canyons, and severely gullied areas (fig. 4). The canyon walls are 350 to 700 feet high. This association covers about 4 percent of the county.

Rough broken land makes up about 70 percent of the association; Potter soils, about 12 percent; Quinlan and Woodward soils, about 8 percent; and minor soils, 10 percent.

Rough broken land consists mostly of steep caliche escarpments and, below the escarpments, sandstone ledges, bluffs, and steep talus slopes, and highly dissected redbed plains.

Potter soils are strongly sloping to steep. These soils have a surface layer of grayish-brown, calcareous gravelly loam that is very shallow over caliche.

The Quinlan soils and Woodward soils are sloping to steep and closely intermingled. The Quinlan soils have a reddish-brown, calcareous very fine sandy loam surface layer about 6 inches thick. The surface layer is underlain by reddish-brown, calcareous very fine sandy loam that extends to a depth of 12 inches. The underlying material is reddish-brown, weakly cemented sandstone.

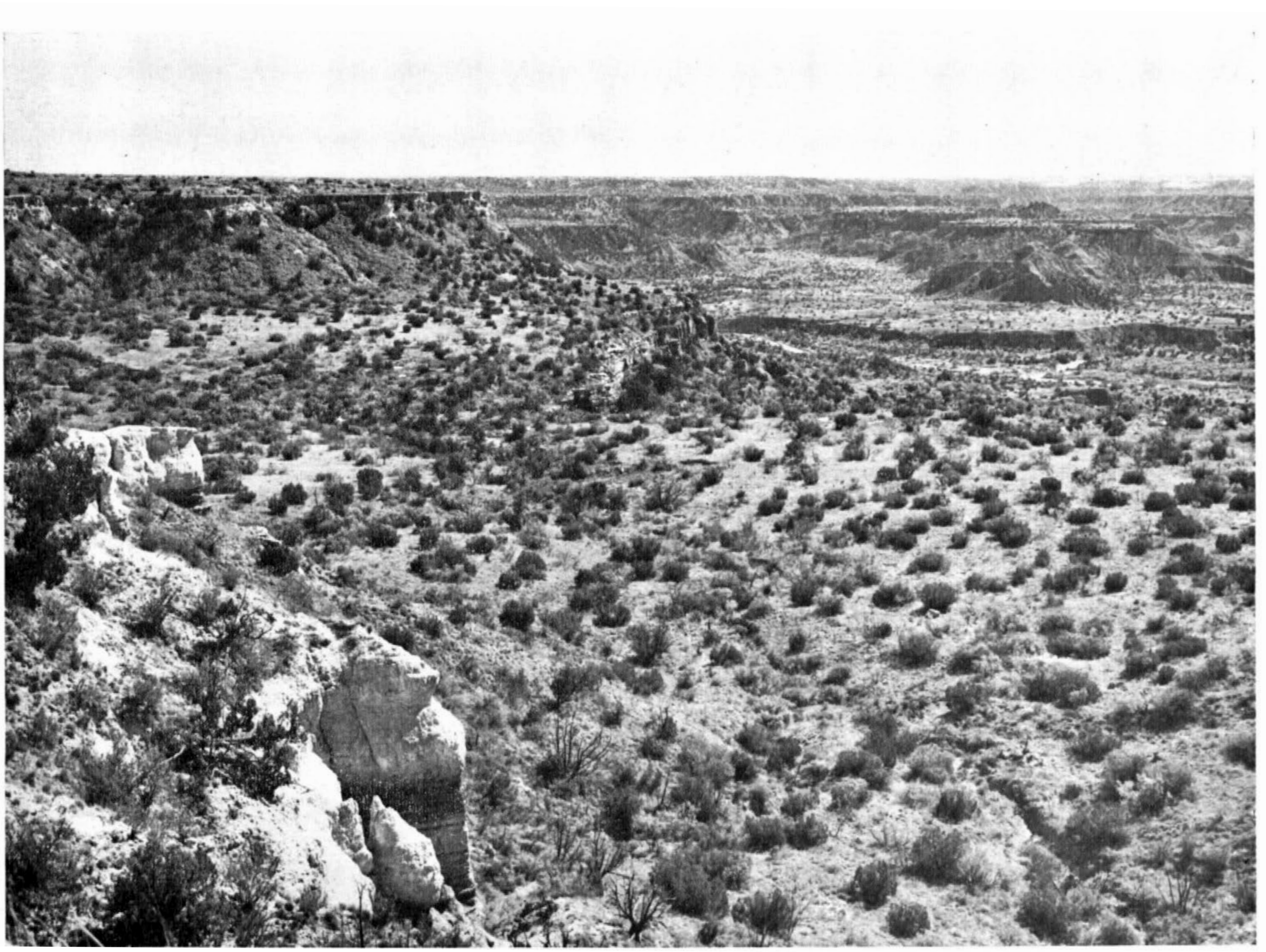

***Figure 4.*—Soil associations 4 and 6, in the eastern part of the county. Rough broken land is prominent in the left background and in the foreground. Soils on escarpments and foot slopes are mostly in soil association 6.**

Woodward soils have a red, calcareous very fine sandy loam surface layer about 10 inches thick. The next layer extends to a depth of 20 inches, and it is reddish-brown, calcareous very fine sandy loam. It is underlain by very fine sandy loam that grades to dark-red, weakly cemented sandstone at a depth of about 36 inches.

Minor soils in this association are in the Mobeetie, Spur, Berda, and Mansker series. Mobeetie, Berda, and Mansker soils are moderately sloping to strongly sloping. They lie along the upper and lower margins of caliche escarpments. Spur soils are nearly level and are along Palo Duro Creek. Mansker soils are sloping to strongly sloping and are on rims or exposures of a few of the larger playas and in areas sloping to drainageways.

Most of this association lies in the Palo Duro State Park. The remaining acreage lies outside the park and is used as range and wildlife habitat, for which the soils are well suited. Most areas furnish an excellent habitat for deer, mountain sheep, and many other kinds of wildlife. About half the acreage is too rugged to be accessible to cattle. Most scenic geological formations in the State are in this association.

5. Mansker-Berda-Potter Association

Gently sloping to sloping, deep, loamy soils on foot slopes, and sloping to steep, loamy soils that are very shallow to moderately deep over caliche

The moderately sloping to steep soils of this association are in long, fairly narrow areas, mainly along draws and in valleys carved by Palo Duro and Tierra Blanca Creeks and their tributaries. Areas range from about one-fourth mile wide in the western side of the county to about 1 mile wide at the Lake Stockton Dam. Within a distance of 100 yards, elevations may vary as much as 300 feet. This association covers about 4 percent of the county.

Mansker soils make up about 55 percent of this association; Berda soils, about 15 percent; Potter soils, about 10 percent; and minor soils, the remaining 20 percent.

Mansker soils occur mostly at the highest elevations in the association. These soils have a brown, calcareous, crumbly clay loam surface layer about 9 inches thick. It is underlain by brown clay loam that extends to a depth of about 19 inches. Concretions cemented by lime are common in this layer. The next layer consists of pinkish-white clay loam and concretions of lime that make up about 45 percent of the layer, by volume.

Berda soils are gently sloping to strongly sloping. They occur on foot slopes between the caliche escarpment and the lower lying flood plains. These soils have a brown, crumbly, calcareous loam surface layer about 9 inches thick. It is underlain by pale-brown, calcareous loam that extends to a depth of 20 inches and that has been highly worked by earthworms. The next layer is light-brown, calcareous loam cemented by common, nodular concretions of lime.

Potter soils are strongly sloping to steep and occur below the Mansker soils at or near the edge of escarpments. These soils have a grayish-brown loam to gravelly loam surface layer about 9 inches thick over a thick bed of caliche.

Kimbrough and Lea soils occur in small areas in this soil association. These soils are closely intermingled loams that are in about the same position in the landscape as the Potter soils.

Most of this association is used for and is well suited as native range. Few areas are suitable for cultivation. The native vegetation is mostly mid grasses, though juniper and catclaw shrubs grow in a few scattered spots. A good cover of grass is difficult to maintain on the very shallow soils. Although well water is limited in quantity in a few areas, its quality is good, and usually there is enough for watering livestock and for home use. A few church camps and recreational areas adjacent to lakes are also in this association.

6. Potter-Mobeetie Association

Moderately sloping to steep, loamy soils on escarpments and foot slopes

Most of this association is in escarpment areas in and around Palo Duro State Park in the eastern part of the county. The soils are moderately sloping to steep. The association is on escarpments between the smooth High Plains tableland of soil association 1 and the lower lying Rough broken land of soil association 4 in Palo Duro Canyon (see fig. 4). This association covers about 3 percent of the county.

Potter soils generally occupy about 45 percent of this association; Mobeetie soils, about 40 percent; and Rough broken land consisting of escarpments of caliche and sandstone, the remaining 15 percent.

Potter soils are gravelly and are strongly sloping to steep. These soils are in higher lying areas above nearly vertical caliche escarpments. They have a surface layer of grayish-brown, calcareous gravelly loam about 9 inches thick over thick caliche.

Mobeetie soils are on colluvial foot slopes below the escarpments. These soils have a grayish-brown, calcareous fine sandy loam surface layer about 10 inches thick. It is underlain by grayish-brown, calcareous, crumbly fine sandy loam that extends to a depth of 28 inches. The underlying layer consists of light brownish-gray, calcareous sandy clay loam that contains many pebbles strongly cemented with lime.

Most of this association, except that in the Palo Duro State Park, is used for native range. The range furnishes only small amounts of forage for beef cattle but is excellent for wildlife habitat. Because of the steep terrain, it is difficult for cattle to graze the higher areas of this association, but the foot slopes provide moderate amounts of forage where cattle trails are accessible. Many rugged, scenic sites, particularly in the Palo Duro State Park, are in this association.

7. Spur-Berda Association

Nearly level to gently sloping, deep, loamy soils on flood plains and foot slopes

The soils of this association are nearly level to gently sloping. They occupy smooth flood plains and adjacent foot slopes along Palo Duro and Tierra Blanca Creeks in the central part of the county. These soils formed in deep, calcareous, stratified alluvium that washed from the higher lying uplands. Most areas receive extra water, mostly as runoff from adjacent slopes above. A few areas along the stream channels are subject to frequent flooding, but most areas are seldom flooded. This association covers 2 percent of the county.

Spur spoils make up about 64 percent of the association;

Berda soils about 10 percent; and the minor soils, the remaining 26 percent.

Spur soils are nearly level and lie along the stream channels. These soils have a dark grayish-brown, calcareous clay loam surface layer about 18 inches thick. Below the surface layer is grayish-brown, calcareous clay loam that extends to a depth of 45 inches. The underlying material is dark grayish-brown calcareous silty clay loam.

Berda soils are gently sloping. They occupy foot slopes at the edge of the bottom lands. Berda soils have a brown, crumbly, calcareous loam surface layer about 12 inches thick. This layer has been highly worked by earthworms. The subsoil is grayish-brown or pale-brown, calcareous loam about 15 inches thick. It is underlain by calcareous, loamy alluvium 3 to 10 feet thick.

The minor soils in this association are the Ulysses, Mansker, and Potter. These soils occur on the higher parts of the side slopes of drainageways.

Most of this association is native range. The native grasses grow well if management is good. Some areas are farmed to alfalfa, small grains, sorghums, and sudangrass. Field crops grow well when moisture content is favorable, but the fields along stream channels are subject to frequent flooding. Runoff water from slopes above is a hazard on the nearly level to gently sloping soils.

Descriptions of the Soils

This section describes the soil series and mapping units of Randall County. The acreage and proportionate extent of each mapping unit are given in table 1.

In this section the procedure is first to describe the soil series and then the mapping units in the series. For full information on any one mapping unit, it is necessary to read the description of that unit and also the description of

TABLE 1.—*Approximate acreage and proportionate extent of the soils* [1]

Soil	Cropland		Range	Total area	Total extent
	Dryland	Irrigated			
	Acres	*Acres*	*Acres*	*Acres*	*Percent*
Acuff loam, 0 to 1 percent slopes	1, 190	(2)	1, 870	3, 060	0. 5
Acuff loam, 1 to 3 percent slopes	970	(2)	1, 540	2, 510	. 4
Amarillo fine sandy loam, 0 to 1 percent slopes	970	(2)	320	1, 290	. 2
Amarillo fine sandy loam, 1 to 3 percent slopes	2, 140	(2)	2, 630	4, 770	. 8
Amarillo fine sandy loam, 3 to 5 percent slopes	150	(2)	850	1, 000	. 2
Berda loam, 1 to 3 percent slopes	135	(2)	835	970	. 2
Berda loam, 3 to 5 percent slopes	(2)	(2)	1, 700	1, 700	. 3
Berda loam, 5 to 12 percent slopes	(2)	(2)	2, 140	2, 140	. 4
Broken alluvial land	(2)	(2)	3, 090	3, 090	. 5
Drake soils, 1 to 3 percent slopes	220	10	1, 260	1, 490	. 3
Drake soils, 3 to 8 percent slopes	410	(2)	1, 565	1, 975	. 3
Kimbrough-Lea loams	(2)	(2)	4, 460	4, 460	. 8
Lofton clay loam	8, 775	1, 050	7, 925	17, 750	3. 0
Mansker clay loam, 0 to 1 percent slopes	430	10	850	1, 290	. 2
Mansker clay loam, 1 to 3 percent slopes	540	70	4, 920	5, 530	. 9
Mansker clay loam, 3 to 5 percent slopes	1, 540	120	12, 870	14, 530	2. 5
Mansker clay loam, 3 to 5 percent slopes, eroded	(2)	(2)	260	260	(3)
Mansker clay loam, 5 to 8 percent slopes	290	(2)	6, 010	6, 300	1. 1
Mobeetie fine sandy loam, 3 to 5 percent slopes	(2)	(2)	1, 980	1, 980	. 3
Mobeetie fine sandy loam, 5 to 12 percent slopes	(2)	(2)	7, 570	7, 570	1. 3
Olton clay loam, 0 to 1 percent slopes	4, 770	(2)	5, 350	10, 120	1. 7
Olton clay loam, 1 to 3 percent slopes	4, 480	(2)	9, 670	14, 150	2. 4
Olton clay loam, 3 to 5 percent slopes	140	(2)	1, 020	1, 160	0. 2
Potter soils	(2)	(2)	12, 560	12, 560	2. 1
Pullman clay loam, 0 to 1 percent slopes	185, 000	79, 000	20, 500	284, 500	48. 3
Pullman clay loam, 1 to 3 percent slopes	32, 500	11, 500	10, 850	54, 850	9. 3
Pullman clay loam, 1 to 3 percent slopes, eroded	2, 730	370	160	3, 260	. 6
Pullman clay loam, moderately shallow, 0 to 1 percent slopes	3, 330	1, 230	3, 780	8, 340	1. 4
Pullman clay loam, moderately shallow, 1 to 3 percent slopes	655	365	780	1, 800	. 3
Quinlan-Woodward complex	(2)	(2)	1, 810	1, 810	. 3
Randall clay	10	(2)	17, 560	17, 570	3. 0
Roscoe clay	2, 950	240	6, 300	9, 490	1. 6
Rough broken land	(2)	(2)	27, 100	27, 100	4. 6
Spur clay loam	2, 270	(2)	3, 180	5, 450	. 9
Spur clay loam, broken	65	(2)	2, 000	2, 065	. 4
Ulysses clay loam, 0 to 1 percent slopes	7, 000	2, 680	5, 300	14, 980	2. 5
Ulysses clay loam, 1 to 3 percent slopes	6, 770	1, 470	12, 970	21, 210	3. 6
Zita clay loam, 0 to 1 percent slopes	3, 650	1, 150	1, 970	6, 770	1. 1
Zita clay loam, 1 to 3 percent slopes	790	190	1, 210	2, 190	. 4
Water areas				5, 760	1. 0
Total	274, 870	99, 455	208, 715	588, 800	100. 0

[1] Land-use acreages were recorded by the survey party as the fieldwork was being done (1955–64), and the figures on cropland and range are from these records.

[2] No acreage in this use.

[3] Less than 0.05 percent.

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the soil series to which it belongs. An essential part of each soil series is the description of the soil profile, or the sequence of layers beginning at the surface and continuing down to depths beyond which roots of most plants do not penetrate. Each soil series contains both a brief nontechnical and a detailed technical description of the soil profile. The nontechnical description will be useful to most readers. The detailed technical description is included for soil scientists and others who need to make thorough and precise studies of the soils. Unless otherwise indicated, the color given in these profiles is that of a dry soil.

Following the name of each mapping unit is a symbol in parentheses that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit (dryland, irrigated, or both), and the range site in which the mapping unit has been placed. The pages on which each capability unit and each range site are described can be found by referring to the "Guide to Mapping Units" at the back of this soil survey. Many terms used in the soil descriptions and other sections are defined in the Glossary and in the "Soil Survey Manual" (*7*).[1]

Acuff Series

The Acuff series consists of deep, dark-brown, well-drained, loamy soils on smooth uplands of the High Plains. Slopes range from 0 to 3 percent, and the surface is plane or convex. These soils developed under short and mid grasses in calcareous loamy material.

In a typical profile, the surface layer of Acuff soils is dark-brown, friable loam about 10 inches thick. The subsoil is reddish-brown and yellowish-red, friable sandy clay loam about 30 inches thick. It is underlain by sandy clay loam that extends to a depth of 85 inches or more and has a prominent accumulation of calcium carbonate in the upper part.

Acuff soils contain moderate amounts of organic matter and are naturally fertile. They are well suited to row crops and native grass.

Typical profile of an Acuff loam (2,700 feet west and 50 feet north of the southeast corner of section 91, block B–5 H. & G.N. Survey; or about 3 miles south and 5 miles west of Canyon) in pasture of native grass:

A1—0 to 10 inches, dark-brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) when moist; moderate, coarse, prismatic structure that breaks to subangular blocky and granular; hard when dry, friable when moist; many, fine, fibrous grass roots; fine and medium pores and channels common; few scattered worm casts and nests in upper part and many in lower part; neutral; noncalcareous; gradual boundary.

B21t—10 to 20 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, coarse, prismatic structure that breaks to moderate, medium, subangular blocky and granular; very hard when dry, friable when moist, plastic when wet; patchy clay films on ped surfaces; more than half of the soil mass is worm casts; roots common; neutral; noncalcareous; gradual boundary.

B22t—20 to 35 inches, reddish-brown (5YR 5/5) sandy clay loam, reddish brown (5YR 4/5) when moist; moderate, medium, prismatic structure breaking to moderate subangular blocky and granular; thin, continuous clay films; very hard when dry, friable when moist, plastic when wet; many worm casts and nests; roots common; fine and very fine channels and pores common throughout; neutral; gradual boundary.

B3—35 to 40 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist; fewer roots and worm casts than in horizons above; few clay films and specks and threads of calcium carbonates on surfaces of peds and on inner walls of many, fine, old root channels; rest of the layer is neutral; clear boundary.

C1ca—40 to 62 inches, pink (5YR 7/3) sandy clay loam, light reddish brown (5YR 6/3) when moist; many, very fine and fine, old root channels throughout this layer; about 40 percent of the layer is visible segregated lime and pockets of weakly and strongly cemented concretions of calcium carbonate; calcareous; moderately alkaline; diffuse boundary.

C2—62 to 85 inches +, light reddish-brown (5YR 6/4) sandy clay loam, reddish brown (5YR 5/4) when moist; hard when dry, friable when moist; many very fine and some fine old root channels; about 10 percent of the horizon is scattered pockets of finely segregated lime; calcareous; moderately alkaline.

The A horizon ranges from light sandy clay loam to loam in texture and from 7 to 12 inches in thickness. When dry, this horizon ranges from dark brown or brown to reddish brown in hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 2 to slightly less than 3.5. When Acuff soils are moist, value ranges from about 2 to slightly less than 3.5 to a depth of 12 to 20 inches.

The B2t horizon ranges from red to reddish brown in hue of 2.5YR or 5YR, value of 4 to 5, and chroma of 3 to 6. Texture is sandy clay loam to light clay loam in places. Clay content ranges from 25 to 35 percent, and silt content is less than 40 percent. The B3 horizon ranges from reddish brown to yellowish red in hue of 2.5YR to 7.5YR.

The C1ca horizon is light brown or pink to pinkish white. Depth to the C1ca horizon ranges from 30 to 70 inches, but is about 40 inches in most places. The C1ca horizon is generally about 15 inches thick, but it ranges from 10 to 25 inches in thickness. The C2 horizon is light reddish brown to yellowish red and is many feet thick.

Acuff soils contain more clay and are darker in the surface layer than the closely associated Amarillo soils and are more sandy throughout the profile than the Olton soils.

Acuff loam, 0 to 1 percent slopes (AcA).—This soil occurs on uplands of the High Plains, south of Palo Duro and Tierra Blanca Creeks between Buffalo Lake and Palo Duro State Park. In most places, the slope is about 0.5 percent and the surface is plane.

The surface layer is dark-brown loam that contains moderate amounts of organic matter. It is about 10 inches thick. The subsoil is moderately permeable, reddish-brown to yellowish-red sandy clay loam about 40 inches thick, but it ranges from 35 to 60 inches in thickness. Underlying the subsoil is a layer of accumulated lime that ranges from light brown or pink to pinkish white in color and from 15 to 25 inches in thickness (fig. 5).

Because some of the silt and clay particles have been winnowed, most areas that were once cultivated have a slightly sandier plow layer than have areas in grass. Much biological activity occurs throughout the solum, which has been deeply leached of free lime.

Included with this soil in mapping were areas of Olton clay loam, generally 3 to 15 acres in size. These included areas require about the same kind of management as Acuff soils. Also included were a few small rises of Amarillo fine sandy loam and spots of Ulysses clay loam. Because these included areas tend to blow if cultivated, they may need special management.

[1] Italic numbers in parentheses refer to Literature Cited, p. 60.

Figure 5.—**Profile of an Acuff loam. The light-colored layer is the zone of lime accumulation.**

This deep, friable soil is easy to work and holds large amounts of available water and plant nutrients. The hazard of soil blowing is slight, and water erosion is not likely.

This soil is well suited to row crops. Nearly half the acreage is in dryfarmed winter wheat and grain sorghum. The rest is native range that still is in blue grama, buffalograss, and little bluestem. (Dryland capability unit IIIce–2; irrigated, I–2; Deep Hardland range site)

Acuff loam, 1 to 3 percent slopes (AcB).—This soil occurs on the High Plains south of Palo Duro and Tierra Blanca Creeks between Buffalo Lake and Palo Duro State Park. The surface is weakly convex or plane, but there are a few slight rises or mounds.

The surface layer is brown to reddish-brown loam about 8 inches thick. The subsoil is reddish-brown, moderately permeable sandy clay loam about 38 inches thick. In the substratum is a pink layer of lime at an average depth of about 45 inches. Most areas that have been tilled for some time have been winnowed of silt and clay particles and have a slightly sandier plow layer than do areas in grass.

Included with this soil in mapping were small raised areas or knolls of Amarillo fine sandy loam that are 5 to 10 acres in size. Also included are narrow bands of a soil that is transitional to Olton clay loam. The Amarillo soils may need some special management because their surface layer is sandy and tends to blow readily. About the same kind of management is needed on the Olton soils as that required for the Acuff soils.

Crop growth is good when moisture content is favorable. This soil is deep, friable, and easy to till. It absorbs water well, and its available water capacity is high.

Nearly half the acreage is dryfarmed, mainly to grain sorghum and winter wheat, and the rest is range. In tilled or overgrazed areas, soil blowing is slight to moderate and water erosion is moderate. (Dryland capability unit IIIe–2; irrigated, IIe–1; Deep Hardland range site)

Amarillo Series

In this series are deep, well-drained, moderately coarse textured soils on uplands of the High Plains. These soils developed under mid and tall grasses in calcareous eolian sediment of the High Plains. They occur on divides, rises, or low dunes above the surrounding plains between Palo Duro State Park and Buffalo Lake. Slopes range from 0 to 5 percent, and the surface is plane or convex.

In a typical profile, the surface layer is brown, friable fine sandy loam about 11 inches thick. The subsoil is reddish-brown and yellowish-red, friable sandy clay loam about 27 inches thick. It is underlain by calcareous loamy material that extends to a depth of 96 inches or more and has a prominent zone of calcium carbonate in the upper part.

Amarillo soils have moderate available water capacity and are naturally fertile. Row crops and native grass are the main uses.

Typical profile of an Amarillo fine sandy loam (on a low smooth rise, 8 feet above the surrounding areas, 525 feet south and 1,600 feet west of the northeast corner of section 98, block 5–B, H. & G.N. Survey; or about 3.2 miles south of Canyon along an undisturbed part of the Panhandle and Sante Fe Railroad right-of-way):

A1—0 to 11 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 3/3) when moist; porous; weak, fine, granular structure and single grain in the upper part and weak, very coarse, prismatic structure in lower part; hard when dry, friable when moist; many, fine, fibrous roots; neutral; gradual boundary.

B21t—11 to 26 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; compound weak, very coarse. prismatic and moderate subangular blocky and granular structure; very hard when dry, friable when moist, slightly sticky when wet; slightly fewer roots than in horizon above; worm casts common; thin, patchy clay films on ped surfaces; many fine and medium pores and root channels; neutral; gradual boundary.

B22t—26 to 35 inches, reddish-brown (5YR 5/5) sandy clay loam, reddish brown (5YR 4/5) when moist; weak to moderate, very coarse, prismatic structure; hard when dry, friable when moist, slightly sticky when wet; patchy clay films common on ped surfaces; many worm casts; many fine and a few medium root channels; fine fibrous roots common; neutral; gradual boundary.

B3—35 to 38 inches, yellowish-red (5YR 5/6) light sandy clay loam, yellowish red (5YR 4/6) when moist; weak, very coarse, prismatic structure that easily breaks to weak granular structure; hard when dry, friable when moist; many fine and a few medium-sized old root channels; worm casts less common as depth increases; neutral in upper part but mildly alkaline and calcareous in lower part, where a few threads and films of calcium carbonate appear between peds and on inner walls of old biological channels; clear boundary.

C1ca—38 to 68 inches, pink (5YR 8/4) light sandy clay loam, light reddish brown (5YR 6/4) when moist; about 35 percent, by volume, is mostly very fine, weakly and strongly cemented concretions of calcium carbonate; moderately alkaline; diffuse boundary.

C2—68 to 96 inches +, reddish-yellow (5YR 7/6) very fine sandy loam, reddish yellow (5YR 6/6) when moist; hard when dry, very friable when moist; hard concretions of calcium carbonate make up about 10 percent of soil mass by volume; many fine and a few medium-sized old root channels; calcareous; moderately alkaline.

The A horizon ranges from 7 to 14 inches in thickness and from fine sandy loam to sandy loam in texture. Color of this horizon ranges from brown to reddish brown in hue of 7.5YR or 5YR. The A horizon has value of 2 or 3 when moist and 4 or 5 when dry. Chroma is 2 to 4.

The B2t horizon has compound structure that is weak, very coarse, prismatic to moderate, medium, subangular blocky and granular. When the B2t horizon is dry, color is generally reddish brown in hue of 5YR but it ranges to brown in hue of 7.5YR.

Depth to the C1ca horizon ranges from 30 to 50 inches. Visible calcium carbonate makes up about 10 to 60 percent of the C1ca horizon, by volume. Color ranges from brown to pink in hue of 7.5YR and 5YR. The C2 horizon is eolian and ranges from loam to fine sandy loam in texture and from light brown to reddish yellow in color.

Amarillo soils are slightly redder, less clayey throughout, and more permeable than the closely associated Acuff soils. Amarillo soils are not so calcareous as Ulysses soils and are deeper and redder.

Amarillo fine sandy loam, 0 to 1 percent slopes (AmA).—This soils occurs on eolian deposits on the High Plains south of the Palo Duro and Tierra Blanca Creeks between Buffalo Lake and Palo Duro State Park. Most areas range from 15 to 100 acres in size, but areas of about 35 acres are dominant.

The surface layer of this soil is brown fine sandy loam about 10 inches thick. The subsoil is about 30 inches thick and is neutral, reddish-brown sandy clay loam in the upper part. The lower part is mildly alkaline and slightly less clayey and more friable than the upper part. The upper layers of this soil are leached of free lime. A pink or pinkish-white layer of accumulated lime is at an average depth of about 40 inches.

Included with this soil in mapping were small areas of Acuff loam and of Olton and Zita clay loams, generally less than 10 acres in size. Under dryland farming these included areas require about the same management as this Amarillo soil.

This soil takes in water readily, is well drained, and holds a moderately large amount of available water. It is friable, fertile, and easily tilled.

This soil is suited to row crops, even in dry years. Nearly half the acreage is used for dryland row crops, and the rest is native range. Underground water for irrigation is not available. (Dryland capability unit IIIe-4; Sandy Loam range site)

Amarillo fine sandy loam, 1 to 3 percent slopes (AmB.)—This soil occupies sloping High Plains south of the Palo Duro and Tierra Blanca Creeks between Buffalo Lake and Palo Duro State Park. Most slopes are about 2 percent. Most areas of this soil range from 25 to 400 acres in size, but areas of about 100 acres are dominant. The surface is convex in most places but plane surfaces occur.

The surface layer is brown to reddish-brown fine sandy loam about 10 inches thick. It is neutral and has weak granular structure. The upper layers are leached of free lime. The subsoil is neutral, reddish-brown sandy clay loam about 30 inches thick. A layer of pink or pinkish-white accumulated lime is at an average depth of about 40 inches.

Included with this soil in mapping were areas of Acuff loam and a few small areas of Olton clay loam. These included areas make up less than 10 percent of any mapped area, and they require the same kind of management as this Amarillo soil.

This deep, moderately fertile soil takes in water readily and has moderately high available water capacity. It is easily tilled.

This soil is well suited to row crops, even in dry years. Nearly half the acreage is in dryland row crops, and the rest is in native grass. Soil blowing and water erosion are likely in overgrazed and unprotected cultivated areas. Underground water for irrigation is not available. (Dryland capability unit IIIe-4; Sandy Loam range site)

Amarillo fine sandy loam, 3 to 5 percent slopes (AmC).—This soil occupies smooth, low dunes on the High Plains south of the Palo Duro and Tierra Blanca Creeks between Buffalo Lake and Palo Duro State Park. Prevailing winds alined the dunes in a northwestward-southwestward direction before they were stabilized by native grass. Dominant slopes are about 5 percent.

The surface layer is reddish-brown, neutral fine sandy loam about 9 inches thick. The subsoil is moderately permeable sandy clay loam about 28 inches thick.

Included with this soil in mapping, in swales between rises or dunes, were a few small areas of Acuff loam.

About 15 percent of this soil is cultivated. Because the risks of soil blowing and gully erosion are severe in cultivated areas, most of the acreage that was once cultivated has been returned to native grass. The rest of the acreage is in native range. Underground water for irrigation is not available. (Dryland capability unit IVe-4; Sandy Loam range site)

Berda Series

The Berda series consists of gently sloping to strongly sloping, well-drained, granular soils of the uplands. These soils are moderately deep over caliche. They occur between the escarpments and the flood plains along Palo Duro Creek and its tributaries. Berda soils formed on foot slopes in local calcareous alluvium and colluvium from the High Plains. The native vegetation was grasses. Soil development has been restricted to a slight movement of lime from the surface layer into the subsoil.

In most areas the surface is plane or weakly concave. Some areas are characterized by a few receding catsteps or scarps. These scarps range from less than 1 foot to as much as 4 feet in thickness, and their number increases as slope increases.

In a typical profile, the surface layer of Berda soils is brown, friable loam about 9 inches thick. The subsoil, about 11 inches thick, is pale-brown loam that contains a few concretions of calcium carbonate. It is underlain by loamy material that is light brown in the upper part and reddish yellow in the lower part. This material extends to a depth of 60 inches or more. Berda soils are used mostly for range.

Typical profile of a Berda loam (0.6 mile east of West Texas State University Stadium and about 75 feet east of railroad track on north side of county road; or about 2 miles north and 0.6 mile east of Canyon) on a foot slope of 5 percent facing southeast:

A1—0 to 9 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; moderate, very coarse, prismatic structure that easily breaks to granular and subangular blocky; slightly to moderately hard when dry, friable when moist; many, fine, fibrous roots and worm casts; a few medium to coarse waterworn concretions of caliche scattered throughout; calcareous; moderately alkaline; gradual boundary.

B2—9 to 20 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) when moist; moderate, coarse to very coarse, prismatic structure breaking to subangular blocky and granular; many worm casts; fine to medium pores common; a few, white, weakly to strongly cemented concretions and masses of calcium carbonate; calcareous; gradual boundary.

C1ca—20 to 45 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 5/4) when moist; moderate, medium, prismatic structure breaking to weak subangular blocky and granular; worm casts common in upper part; many, fine, old root channels; calcareous and moderately alkaline; about 3 percent of volume is weakly cemented and some strongly cemented and nodular concretions of calcium carbonate; gradual boundary.

IIC2—45 to 60 inches +, reddish-yellow (7.5YR 6/5) clay loam, strong brown (7.5YR 5/5) when moist; hard when dry, friable when moist, slightly sticky when wet; a few threads of calcium carbonate; moderately alkaline.

The A horizon is dominantly loam but ranges from clay loam to sandy clay loam in texture and from 6 to 12 inches in thickness. When dry, the A horizon ranges from brown to grayish brown in hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3.

The B2 horizon ranges from 8 to 15 inches in thickness. It contains slightly more clay than the A horizon; clay content ranges from 25 to 35 percent. The color value of the B2 horizon is about one Munsell notation lighter than that of the A horizon. In most places a large part of the B2 horizon is worm casts. For less than 180 days in a year, Berda soils are dry between depths of 10 and 40 inches. In most places the B2 horizon has some scattered, medium to coarse, strongly cemented, nodular caliche concretions. The amount of concretions normally increases with increasing slope.

Visible calcium carbonate in the C1ca horizon ranges from 0 to 5 percent, by volume. The IIC2 horizon consists of local alluvium-colluvium and ranges from 2 to 10 feet or more in thickness. In most places it rests on residual Ogallala material.

Berda soils have similar horizonation to that of Mobeetie soils, but they contain less sand and are less permeable. They lack the prominent lime accumulation that is in the substratum of the Mansker soils.

Berda loam, 1 to 3 percent slopes (BeB).—This soil occurs on the lower foot slopes, flats, and fans along the main drainageways of the county. Slope is about 2 percent in most places. The surface is weakly concave or plane.

The surface layer is dark grayish-brown, friable loam about 12 inches thick. Both this layer and the subsoil are dominantly worm casts. The subsoil is grayish-brown, calcareous loam about 15 inches thick. It is underlain by calcareous local alluvium that ranges from 3 to 7 feet in thickness.

This soil absorbs water well and holds moderately large amounts of available moisture and plant nutrients. It is easy to work, and crops grow well when moisture is favorable. Because this soil receives extra water from soils upslope, native grasses are generally well suited. Cultivated crops are also well suited, but water erosion is a moderate hazard in sloping areas that are not protected.

Only a few fields are cultivated, and these are used for dryland farming. The remaining acreage is in native grass and some herbs and forbs. (Dryland capability unit IIIe–3; irrigated, IIIe–4; Hardland Slopes range site)

Berda loam, 3 to 5 percent slopes (BeC).—This soil occupies the relatively smooth foot slopes in the valley of Palo Duro Creek and the valleys and draws of its tributaries. Slopes are dominantly about 4 percent. The surface is generally concave or plane, but in a few places it is convex. The few shallow, receding scarps, or catsteps, on the native range are the result of geologic erosion.

The surface layer is brown to grayish-brown, calcareous loam about 9 inches thick (fig. 6). This layer and the subsoil are friable and dominantly made up of earthworm

Figure 6.—**Profile of Berda loam showing prismatic structure. Below a depth of 20 inches is a layer of accumulated lime.**

casts. In most places there are scattered, fine- to medium-sized pebbles or nodular concretions of caliche from Potter soils upslope. A weak layer of accumulated lime is generally at a depth of about 25 inches. It is underlain by local alluvium several feet thick and, in most places, is underlain by residual Ogallala material.

Included with this soil in mapping were small spots of Potter soils and Mansker clay loam that are mostly in the higher, more sloping parts. Also included, on the lower slopes, are small areas of Berda loam that have slopes of less than 3 percent. The included areas make up less than 10 percent of any mapped area.

This soil takes in water well. It has moderate available water capacity and natural fertility.

All of this soil is range. Under good management native grass grows well. Cultivated areas require much care because the hazard of sheet and gully erosion is moderately severe and the hazard of soil blowing is moderate. (Dryland capability unit IVe-2; irrigated, IIIe-2; Hardland Slopes range site)

Berda loam, 5 to 12 percent slopes (BeD).—This soil occupies the foot slopes along the Palo Duro Canyon and adjoining valleys and major draws. Slopes are about 8 percent in most places. The surface is generally concave or plane, but in a few places it is convex. Shallow, receding scarps, called catsteps, are the result of geologic erosion. This soil has more of these scarps than has Berda loam, 3 to 5 percent slopes.

The surface layer is grayish-brown, calcareous loam about 8 inches thick. This layer and the subsoil are friable and are largely made up of earthworm casts. Medium to coarse nodules of caliche are scattered throughout the soil and make up about 5 percent, by volume. At a depth of about 22 inches is a weakly developed zone of accumulated lime. The somewhat stratified, strongly calcareous underlying material is several feet thick and generally overlies residual Ogallala material.

Included in mapping, on the stronger upper slopes, were small areas of Potter soils and of Rough broken land consisting of caliche outcrops at or near the escarpments. Spots of Berda loam having slopes of less than 5 percent occur at the lower elevations. The included areas make up about 15 percent of the area mapped.

This Berda soil absorbs moisture well. Available moisture capacity and natural fertility are moderate to moderately low.

Under good management, native short and mid grasses and forbs grow well. This soil is susceptible to severe water erosion and to slight soil blowing. (Dryland capability unit VIe-1; Hardland Slopes range site)

Broken Alluvial Land

Broken alluvial land (Br) consists of unclassified soils of variable texture and depth. It is nearly level to moderately sloping. The soil material consists of stratified alluvium that has loamy texture. When streams overflow, damaging flooding is likely and sterile sand is deposited in some areas. Scar channels are common, and in some places further channel cutting is likely. Flooding is likely after heavy rains and usually occurs about two or three times a year.

Typical areas of Broken alluvial land occur on the lower part of the flood plain below Lake Stockton Dam along Palo Duro Creek and in the Palo Duro Canyon within the Palo Duro State Park.

The surface layer is calcareous, brown to reddish-brown, stratified sandy loam, fine sandy loam, loam, and sandy clay loam. In places there are waterworn quartz and caliche pebbles scattered throughout the profile. Also, a layer of gravel and sandstone fragments is at a depth of more than 15 inches in some places.

Drainage is somewhat excessive; surface drainage is medium, and internal drainage is moderately rapid. The subsoil has moderately rapid permeability.

Included in the areas mapped were spots of Spur soils, cut banks, and barren stream channels. The included areas make up about 15 percent of the mapped areas.

Broken alluvial land is not suitable for cultivation, but it is used as range and wildlife habitat and for recreational purposes. Because it receives extra runoff water from adjacent soils, growth of tall and mid grasses, herbs, and trees is good to excellent. Most areas of Broken alluvial land are infested with moderate to heavy stands of mesquite. A few native willow and cottonwood trees occur along the streambanks. (Dryland capability unit Vw-1; Loamy Bottomland range site)

Drake Series

The Drake series consists of light-colored, limy, loamy soils that formed in fairly recent eolian deposits. Slopes range from 1 to 8 percent but are dominantly 2 to 8 percent. The largest area is in Umbarger Basin on the east side of Buffalo Lake. This basin has been dissected and drained by Tierra Blanca Creek. Drake soils occupy smooth, crescent-shaped or oblong dunes, which partly encircle the larger playas at their leeward side. The dunes formed from sediments blown from the bottoms of playas.

In a typical profile, the surface layer of the Drake soils is light brownish-gray, very friable clay loam about 9 inches thick. The next layer is light-gray, friable clay loam about 9 inches thick. It is underlain by clay loam that extends to a depth of 60 inches or more.

These soils are well suited as rangeland, but the risk of soil blowing is severe in overgrazed areas.

Typical profile of a Drake clay loam (on a low, gently sloping dune on the leeward side of the large playa, 1,550 feet east and 425 feet north of the southwest corner of section 44, block M-9, John Gibson Survey; or about 4 miles east and 1 mile north of Happy) in a cultivated field:

Ap—0 to 9 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; many worm casts; hard when dry, very friable when moist; common, fine, fibrous roots; common fine biological channels and pores; calcareous; moderately alkaline; gradual boundary.

C1—9 to 18 inches, light-gray (10YR 6/1) clay loam, grayish brown (10YR 5/2) when moist; porous; moderate, medium, granular structure; granules consist mainly of worm casts; hard when dry, friable when moist, sticky when wet, fewer fine fibrous roots than in the Ap horizon; many very fine pores; calcareous; moderately alakaline; diffuse boundary.

C2—18 to 60 inches +, white (2.5Y 8/0) clay loam, light gray (2.5Y 7/2) when moist; very fine, chalky, eolian granules; slightly hard when dry, very friable when moist, sticky when wet; few fine roots in upper part; many very fine pores; earthen material contains much uniformly dispersed lime; calcareous; moderately alkaline.

The A horizon ranges from 5 to 10 inches in thickness and is thinnest on the crests of the dunes. When the A horizon is dry, color ranges from gray to brownish gray and light brownish gray in hue of 10YR and value of 5 or 6. When the A horizon is moist, it has value of 3.5 to 4 and chroma of 1 or 2. Structure in undisturbed areas is uniformly granular, but the plow layer of fields that have been tilled for some time is structureless.

The C1 horizon ranges from 9 to 25 inches in thickness. Its color value is generally about one Munsell notation lighter than that of the A horizon.

The C2 horizon normally ranges from 2 to 7 feet in thickness and from clay loam to loam in texture. It is white or light gray.

In some part of the zone between depths of 10 and 40 inches, these soils are dry for less than 180 days.

Drake soils are lighter colored and more limy than the closely associated Ulysses, Mansker, and Zita soils. They lack the distinct layers of accumulated lime in the substratum of those soils.

Drake soils, 1 to 3 percent slopes (DrB).—These soils are enriched with lime. They occur on smooth, crescent-shaped or oblong dunes on the leeward (east and southeast) edge of the larger playas in the county. Dunes range from 10 to 25 acres in sizes and from 3 to 10 feet in height. The largest area of these soils is in the Umbarger Basin, east of Buffalo Lake.

Throughout the profile, Drake soils range from light brownish gray to grayish brown and are very limy and granular. The granules are largely worm casts. The surface layer ranges from 5 to 10 inches in thickness. It is mostly clay loam but ranges from clay to sandy loam. This layer is the thinnest and coarsest at or near the crest of the dunes. The subsoil ranges from 10 to 25 inches in thickness. It is light gray and contains much dispersed lime. Underlying the subsoil are very limy stratified sediments that were blown from bottoms of adjoining playas. Permeability is moderate.

Included in mapping were a few, small, narrow bands that are transitional from the steeper Drake soils to Ulysses clay loam. Also included are a few areas of soils that have a clay surface layer. The included areas make up less than 8 percent of any area mapped.

These soils absorb water fairly well and have moderate to low available water capacity. Tilled areas are very susceptible to soil blowing and water erosion.

Most areas that have been dryfarmed have since been reestablished to native grass. Range is the main use, because dryfarming such droughty soils is very risky. Sorghums are likely to be damaged by lime-induced chlorosis. (Dryland capability unit IVes–1; irrigated, IIIes–1; High Lime range site)

Drake soils, 3 to 8 percent slopes (DrD).—These soils are on smooth dunes on uplands on the leeward (east and southeast) edge of the larger playas in the county. These dunes range from about 15 to 60 acres in size and from 5 to 25 feet in height. The largest area of these soils is in the Umbarger Basin, east of Buffalo Lake.

The surface layer is light brownish-gray, granular, limy clay loam to fine sandy loam about 6 inches thick. The subsoil is light-gray, moderately permeable, granular clay loam that is strongly limy and about 11 inches thick. Underlying the subsoil is stratified, limy eolian silty clay loam.

Included in mapping were some areas of Drake soils on crests of dunes and on slopes of more than 8 percent. Also included were small areas having slopes of less than 3 percent. The included areas make up about 15 percent of any area mapped.

These soils take in water fairly well and have a fair capacity for holding it available for plants. Excessive lime, however, ties up plant nutrients and causes chlorosis in many fields of grain sorghum.

Because these soils are limy, sloping, and extremely susceptible to water erosion and soil blowing, most areas that were dryfarmed have since been reestablished in native grass. These soils are mostly range, but a few fields are dryfarmed. (Dryland capability unit VIe–3; High Lime range site)

Kimbrough Series

In the Kimbrough series are loamy soils on uplands of the High Plains. These soils are very shallow to indurated caliche. They developed under short grasses in a thin layer of loamy material. Kimbrough soils are gently sloping and occur mainly on knolls and ridges, mostly near the escarpments of Tierra Blanca Creek and its tributaries.

In a typical profile, the surface layer of these soils is calcareous, dark grayish-brown loam about 8 inches thick. The next layer extends to a depth of more than 36 inches and consists mostly of pinkish-white, indurated caliche.

Kimbrough soils are used mostly for grazing. The hard caliche in the substratum is much in demand for use in roadbuilding.

Typical profile of a Kimbrough loam (about 2.5 miles south of Buffalo Lake on the east side of paved Farm Road No. 168) in a pit recently dug in caliche:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/3) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist, and slightly sticky when wet; many, fine, fibrous roots at contact with large indurated plates of caliche; many worm casts; few, scattered, angular fragments of hard caliche on surface and throughout the horizon; calcareous; moderately alkaline; abrupt, irregular boundary.

Ccam—8 to 36 inches +, pinkish-white (7.5YR 8/2) indurated caliche; hardened caliche is about 95 percent of the layer, by volume; plates are smooth on the upper surfaces and have a secondary limy undercoating consisting of round, pea-shaped concretions mainly 2 to 5 millimeters in diameter; less than 5 percent of the layer is loamy, calcareous, massive material that is grayish brown (10YR 5/2) when dry and contains many worm casts and fine and medium roots in fissures and between plates; fine material decreases with depth.

The A1 horizon ranges from 7 to 15 inches in thickness. When this horizon is dry, color ranges from grayish brown to dark grayish brown in hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. Value is less than 3.5 when the A1 horizon is moist.

The Ccam horizon ranges from 3 to 6 feet in thickness. It is underlain by more weakly cemented caliche that is many feet thick. The hardened caliche is made up of indurated plates that are mostly 10 to 40 inches in diameter and 2 to 6 inches or more thick. Most plates overlap as much as 10 to 30 percent and make up more than 95 percent of the volume. The remaining 5 percent is soil material that has worked down from the surface layer and is in the cracks in the weakly cemented, dovetailed joints between the edges of adjoining plates.

Kimbrough soils are shallower over indurated caliche than the closely associated Lea soils and are calcareous throughout. Kimbrough soils are less limy than the Potter soils and have a substratum of harder caliche.

Kimbrough-Lea loams (Ke).—This complex consists of closely intermingled soils that are very shallow to moderately deep over hard, rocklike caliche. The areas occur along the caliche escarpment of the Tierra Blanca Creek and its tributaries. The gently sloping Kimbrough loam occupies the knolls and ridges, but the less sloping Lea loam occurs in slightly depressional areas.

In this complex Kimbrough loam makes up about 55 percent of the acreage; Lea loam, 30 percent; and other soils, 15 percent. The soils are mapped as a complex because they are so intermingled that they could not be shown separately on a map of the scale used.

The Kimbrough soil consists of 7 to 15 inches of dark grayish-brown, calcareous, friable loam that is underlain by a thick substratum of indurated caliche (fig. 7). Some scattered, angular fragments of indurated, platy caliche occur on the surface and throughout the solum. The Lea soil has a surface layer of dark grayish-brown, noncalcareous loam 7 to 12 inches thick. The subsoil is moderately permeable, brown light clay. Thick indurated caliche is at a depth of more than 20 inches. The Lea soil is thicker over caliche than the Kimbrough soil and contains less free lime and fewer fragments of hard caliche.

Included with these soils were small areas of Potter soils and a few spots of Mansker soils that together make up about 15 percent of the area mapped.

Most of this complex is used as range. Kimbrough and Lea soils support similar kinds of native grasses, but the density of cover differs. Lea loam has fairly dense stands of blue grama, buffalograss, and other short grasses, but Kimbrough loam has sparse stands. A scattering of tree cactus (cholla) commonly grows on the soils of this complex. The thicker beds of indurated caliche are used locally as roadbuilding material. (Dryland capability unit VIIs-1; Very Shallow range site)

Figure 7.—**Kimbrough loam in the complex Kimbrough-Lea loams. Thick indurated caliche is at a depth ranging from 7 to 15 inches.**

Lea Series

The Lea series consists of gently sloping, loamy soils of the uplands. These soils are moderately deep to indurated caliche. They occur with Kimbrough soils, mostly south of Tierra Blanca Creek. Slopes range from 1 to 4 percent, and the surface is plane or convex. These soils formed in loamy material of the High Plains under native short grasses.

In a typical profile, the surface layer is dark grayish-brown, friable loam about 7 inches thick. The subsoil is brown, friable light clay loam about 15 inches thick. It is underlain by overlapping plates of caliche.

All of the acreage of Lea soils is range. In some areas the caliche is mined in pits and then crushed for use in building roads. In Randall County Lea soils are mapped only in a complex with Kimbrough soils.

Typical profile of Lea loam (in Kimbrough-Lea loams adjacent to a newly cut face of a caliche pit, about 2.5 miles south of Buffalo Lake on the east side of paved Farm Road No. 168):

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist, slightly sticky when wet; many, fine, fibrous roots; worm casts common in upper part and many in lower part; many fine biological channels and pores; neutral; gradual boundary.

B2—7 to 22 inches, brown (7.5YR 5/3) light clay loam, dark brown (7.5YR 4/3) when moist; moderate, medium, subangular blocky and granular structure; hard when dry, friable when moist, slightly sticky when wet; fine fibrous roots common; many very fine and some fine pores and root channels; many worm casts; a scattering of threads and fine concretions of calcium carbonate; calcareous; mildly alkaline; abrupt, irregular boundary.

Ccam—22 to 40 inches, pinkish-white (7.5YR 8/2), very coarse, indurated, overlapping plates of caliche; about 5 percent, by volume, is light-brown, strongly granular loam consisting mostly of worm casts; some plant roots fill the cracks and voids in the upper part; calcareous.

The A horizon ranges from 7 to 12 inches in thickness. Its texture is dominantly loam, but it is clay loam in some places. When the A horizon is dry, color is dark grayish brown or grayish brown to brown in hue of 10YR and value of 4 or 5, but value is less than 3.5 and chroma is 2 or 3 when it is moist.

The B2 horizon ranges from 9 to 15 inches in thickness and is granular to weak subangular blocky clay loam. When it is dry, color ranges from brown to grayish brown in hue of 10YR or 7.5YR and value of 5 or 6. When the B2 horizon is moist, the value is 3 or 4 and chroma is 2 or 3.

The solum ranges from 20 to 30 inches in thickness. The underlying material is indurated caliche similar to that underlying the Kimbrough soils, except that it normally begins at a depth of 20 inches. Below a depth of 40 inches the caliche is less cemented.

The solum of the Lea soils is thicker than that of Kimbrough soils. Lea soils are similar to Mansker soils in horizonation and depth, but unlike those soils, are underlain by indurated caliche.

Lofton Series

The Lofton series consists of deep, dark-colored soils that occur on smooth upper playa benches and slight depressions within broad areas of Pullman soils on the High Plains. Slopes range from 0 to 2 percent but are mostly less than 0.5 percent. These soils receive extra water as runoff from the surrounding, higher lying soils. They have

a higher content of organic matter and support thicker stands of native grasses than the Pullman and Ulysses soils.

In a typical profile, the surface layer of Lofton soils is dark grayish-brown, friable clay loam about 8 inches thick. The subsoil is very firm, dark grayish-brown clay that extends to a depth of 52 inches. The underlying layer is clay and clay loam that extends to a depth of 84 inches or more.

Lofton soils are among the best soils for farming in the county. They are well suited to cultivated crops and native grass.

Typical profile of Lofton clay loam (in an irrigated wheatfield extending into a large playa, 1,500 feet north and 2,300 feet west of the southwest corner of section 29, block M–9, John H. Gibson Survey; or about 3.5 miles east and 1.2 miles north of Happy):

Ap—0 to 8 inches, dark grayish-brown (10YR 4/1.5) clay loam, very dark grayish brown (10YR 3/1.5) when moist; weak, fine, granular structure and massive; hard when dry, friable when moist, slightly sticky when wet; a few fragments of underlying horizon brought up by tillage; many wheat roots; neutral; abrupt boundary.

B21t—8 to 23 inches, dark grayish-brown (10YR 4/1.5) clay, very dark grayish brown (10YR 3/1.5) when moist; moderate, medium, blocky structure when dry and massive when wet; some micronodular or knobby ped surfaces; clay films continuous; extremely hard when dry, very firm when moist, sticky and plastic when wet; neutral; gradual boundary.

B22t—23 to 38 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; strong, medium, blocky structure when dry and massive when wet; axis of horizontal peds about one-third longer than vertical axis; some peds are wedge shaped and show pressure faces that are tilted 10 to 15 degrees from the horizontal; extremely hard when dry, very firm when moist; clay films continuous; few threads and films of calcium carbonate in lower part; few, very fine, old root channels in lower part; calcareous; mildly alkaline; gradual boundary.

B3—38 to 52 inches, grayish-brown (10YR 5/2) light clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium, blocky structure when dry and massive when wet; very hard when dry, firm when moist, plastic and sticky when wet; fewer fine, fibrous roots than horizons above; fine and very fine old root channels common; clay films less prominent than in layer above and appear to be patchy; specks, threads, films, and very fine, imbedded segregated concretions of calcium carbonate become more common with depth and mostly occur between vertical walls of peds; calcareous; mildly alkaline; clear boundary.

C1ca—52 to 60 inches, pink (7.5YR 7/3) clay, light brown (7.5YR 6/4) when moist; near massive; large amount of very fine, segregated, chalky concretions of calcium carbonate; a few medium-sized chalky concretions and a few strongly cemented concretions of similar material; calcareous; moderately alkaline; gradual boundary.

C2—60 to 84 inches +, reddish-yellow (7.5YR 6/6) clay loam, strong brown (7.5YR 5/6) when moist; massive; small to medium-sized, widely scattered pockets of mostly chalky or weakly cemented concretions of calcium carbonate; some imbedded strongly cemented concretions of calcium carbonate; soil material has dark weblike films or stains, probably of iron or manganese; films or stains are few in upper part and common in the lower part.

The A horizon ranges from 7 to 11 inches in thickness. When dry, the A horizon ranges from very dark grayish brown to very dark gray. Hue is 10YR, and value is 3 to 4.5 when A horizon is dry and 2 to 3 when it is moist. Chroma is 1.5 or 2. Texture is clay loam in most places but ranges to silty clay loam. In areas that have been tilled for some time, structure is weak, fine, granular. In undisturbed areas structure is moderate, fine to medium, granular that grades to moderate, medium, subangular blocky in the lower part.

The B2t horizon ranges from 20 to 40 inches in thickness. It has moderate or strong, medium, blocky structure. When this horizon is dry, cracks 0.3 to 1.5 inches wide and 12 to 15 inches long extend to a depth of 1.5 to 3 feet. Reaction is neutral in the upper part, but it is mildly alkaline in the lower part.

The B3 horizon ranges from 10 to 30 inches in thickness. Structure is moderate or weak, coarse, prismatic. In some places a buried soil horizon (B2b) of reddish-brown, coarse blocky heavy clay loam occurs. The buried soil horizon generally ranges from 7 to 15 inches in thickness.

Depth to the C1ca horizon ranges from 45 to 60 inches. The C1ca horizon contains from less than 1 to as much as 30 percent of visible, weakly cemented to strongly cemented concretions of calcium carbonate. The C2 horizon of reddish-yellow to yellowish-brown, massive, calcareous or alkaline material has scattered, variable-sized pockets filled with weakly to strongly cemented concretions of calcium carbonate.

Lofton soils resemble the Pullman soils in texture, structure, and horizonation, but they are darker in the upper part and have grayish colors in the subsoil. Lofton soils are less clayey, are better drained, and show more distinct horizonation than the Roscoe or Randall soils.

Lofton clay loam (Lo).—This soil occurs on smooth upper playa benches and slight depressions within broad areas of the Pullman soils throughout the High Plains. It is one of the most important soils for farming in the county, because it receives extra runoff water from the surrounding, higher lying soils. Most areas range from 30 to 200 acres in size, but the areas are dominantly about 90 acres. They are generally crescent to ovoidal in shape. Slopes are mostly less than 0.5 percent but in places range up to 2 percent. The surface is weakly concave or plane.

The profile of this soil is the one described as typical for the Lofton series. The surface layer is dark grayish-brown, neutral clay loam about 8 inches thick (fig. 8). In undisturbed areas, the organic-matter content and fertility are high. Structure is moderate to strong granular under native grass, but in cultivated areas it is weak, fine, granular and the surface is cloddy.

The subsoil is slowly permeable, blocky clay about 45 inches thick. When it is dry, large deep shrinkage cracks penetrate the solum. Underlying the subsoil is a light-brown to pink layer of accumulated lime that is weakly to strongly developed.

Included in mapped areas were small depressions of Randall clay and a few, narrow, transitional bands of Roscoe clay totaling as much as about 10 percent of the mapped area. They offer some problems in management, because they have higher clay content and slower permeability than the other soils in this unit.

Lofton clay loam absorbs water slowly, but capacity for holding available moisture and plant nutrients is high.

About 55 percent of this soil is cropland, and the rest is range. Of the cropland, about 90 percent is dryfarmed. Except in the driest years, dryland crops grow well if management is good. Irrigated crops also are well suited. This is one of the best soils in the county for farming. (Dryland capability unit IIIce–1; irrigated, IIs–1; Deep Hardland range site)

Mansker Series

The Mansker series consists of calcareous, loamy, nearly level to strongly sloping soils of the High Plains. These soils are moderately shallow over caliche. They occur

Figure 8.—**Profile of Lofton clay loam.**

throughout the uplands in the county, except in Palo Duro Canyon. Mansker soils mainly occupy the rims or exposures of some of the larger playas and areas that slope to the drainageways extending across the High Plains. Some small- to medium-sized, nearly level areas occur within larger areas of Ulysses soils.

In a typical profile, the surface layer of the Mansker soils is brown, very friable clay loam about 9 inches thick. It is underlain by a clay loam subsoil about 10 inches thick. Calcium carbonate has accumulated between depths of about 9 and 30 inches. The underlying material is clay loam that extends to a depth of 56 inches or more.

Most of the acreage of Mansker soils is rangeland. Irrigated grain sorghum and alfalfa are grown in a few areas.

Typical profile of a Mansker clay loam (on a south exposure of a playa rim, approximately 2,700 feet west and 1,875 feet south of the northeast corner of section 43, block 6, I. & G.N. Railroad Survey; or about 6.5 miles west and 3.5 miles north of Canyon) in pasture of native grass:

A1—0 to 9 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure that easily breaks to compound weak subangular blocky and moderate, fine and medium, granular structure; soil mass is mostly worm casts; slightly hard when dry, very friable when moist; many, fine, fibrous roots; few medium-sized roots; many fine- and medium-sized biological pores and channels; few rodent holes and diggings; few, scattered, fine, weakly and strongly cemented concretions of calcium carbonate in lower part; calcareous; moderately alkaline; gradual boundary.

B2ca—9 to 19 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; weak prismatic structure that easily breaks to fine and medium granular; material is made up mostly of worm casts; hard when dry, friable when moist, sticky when wet; roots common; fine and medium pores and channels common; scattered, fine and medium, weakly and strongly cemented calcium carbonate concretions that increase in amount with depth; calcareous; moderately alkaline; clear boundary.

C1ca—19 to 30 inches, pinkish-white (7.5YR 8/2) clay loam, pinkish gray (7.5YR 6/2) when moist; irregularly shaped masses of weakly and strongly cemented concretions of calcium carbonate that make up about 45 percent of the horizon, by volume; the rest is pinkish-gray, granular material consisting mostly of worm casts; few, fine, fibrous roots; many, fine and very fine, old root channels; calcareous; moderately alkaline; gradual boundary.

C2—30 to 56 inches +, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) when moist; structureless (massive); hard when dry, slightly firm when moist; fine and very fine, old root channels common; few, scattered, irregularly shaped and sized pockets of weakly and strongly cemented concretions of calcium carbonate; calcareous; mildly alkaline.

The A1 horizon ranges from 7 to 12 inches in thickness. When this horizon is dry, its color ranges from grayish brown to dark grayish brown or brown in hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. Texture is clay loam in most places but ranges from clay loam to fine sandy loam. This horizon is calcareous. It is mildly alkaline to moderately alkaline.

Few to many, scattered, fine- to medium-sized, strongly to weakly cemented concretions of calcium carbonate occur in the B2ca horizon. The amount of concretions increases as depth increases.

The C1ca horizon ranges from pink to pinkish white. It is generally at a depth of 11 to 20 inches. Thickness ranges from about 1 to 3 feet. The content of visible calcium carbonate ranges from 10 to 50 percent or more.

Mansker soils are shallower over caliche and more limy than the associated Ulysses soils but are darker and are deeper over caliche than the Potter soils.

Mansker clay loam, 0 to 1 percent slopes (MkA).—This soil occurs on loessal uplands. Most areas are small and are irregular to curvilinear in shape. This soil generally occurs within larger areas of Ulysses clay loam, 0 to 1 percent slopes, in the central and southwestern parts of the county.

Except that the surface layer is slightly thicker, the profile of this soil is similar to the one described as typical for the Mansker series. The surface layer is very friable, calcareous, brown to grayish-brown clay loam about 10 inches thick. The subsoil is moderately permeable. It is generally lighter colored than the surface layer and contains slightly more lime and clay.

Included with this soil in mapping were small, narrow areas that are transitional to Ulysses clay loam.

This Mansker soil takes in water well and is easy to till, but its available water capacity and natural fertility are

moderately low. Because it is limy and low in organic-matter content, the surface fluffs up, powders, and is susceptible to blowing.

About two-thirds of this soil is native range. Because the lime in this soil induces chlorosis, dryland grain sorghum usually does not grow well during dry years. Alfalfa is tolerant of lime and is better suited than other crops if water is available for irrigation. (Dryland capability unit IVe–9; irrigated, IIIe–10; Hardland Slopes range site)

Mansker clay loam, 1 to 3 percent slopes (MkB).—This soil occupies the draws and rims of some of the larger playas in the county. In most places this soil is slightly lighter colored, more limy, and shallower over caliche than Mansker clay loam, 0 to 1 percent slopes. Slopes are mostly about 2.5 percent, and the surface is convex.

The surface layer is calcareous, grayish-brown, very friable clay loam about 8 inches thick (fig. 9). The subsoil

Figure 9.—**Profile of a Mansker clay loam. Lime concretions are prominent in the light-colored Cca horizon.**

contains more lime than the surface layer and consists of moderately permeable clay loam about 7 inches thick. At an average depth of 14 inches is an accumulation of mixed, weakly cemented and somewhat hard, white to pinkish-white caliche.

Included with this soil in mapping were a few spots of Potter soils and some small, narrow areas transitional to Ulysses clay loam.

This soil takes in water well, but its available water capacity and natural fertility are moderately low. Because it is high in lime, it tends to fluff up, become powdery, and to blow readily in unprotected areas. In sloping areas, it washes and forms rills and gullies.

Nearly all this soil is in native grass. Alfalfa is tolerant of lime and grows exceptionally well where irrigation water is available. (Dryland capability unit IVe–9; irrigated, IIIe–10; Hardland Slopes range site)

Mansker clay loam, 3 to 5 percent slopes (MkC).—This soil occupies rims on the north and northeast sides of the larger playas. It is in areas that slope to draws. Most areas are in narrows, long bands that parallel the more strongly sloping areas. Areas have an average size of about 35 acres and a strongly convex surface.

The surface layer is grayish-brown, calcareous clay loam about 7 inches thick. The subsoil is moderately permeable clay loam about 7 inches thick. It overlies weakly cemented to somewhat hard caliche at a depth of about 11 to 15 inches.

Included with this soil in mapping were small spots of Potter soils and of Ulysses clay loam and Mansker clay loam. These included areas make up about 15 percent of any area mapped.

This Mansker soil takes in water well, but its available water capacity is low.

Except for some areas that are tilled with adjoining, better soils, all of this soil is range. Because of the liminess and moderate slopes, the hazard of erosion is severe. (Dryland capability unit IVe–2; irrigated, IVe–6; Hardland Slopes range site)

Mansker clay loam, 3 to 5 percent slopes, eroded (MkC2).—Most areas of this calcareous soil occur on rims of a few large playas and draws that are cultivated with adjoining, more productive soils. The areas average about 30 acres in size, and they are long, narrow, and band shaped. Slopes average about 4 percent, and the surface is strongly convex.

The surface layer of this soil originally was grayish-brown loam or clay loam about 7 inches thick, but about half of it has washed or blown away. This soil is now cut by numerous shallow, crossable gullies, but in a few places the gullies are so deep that farm machines cannot cross them and the underlying material is exposed.

Included with this soil in mapping were a few spots of Potter soils.

The solum of this soil is thinner than the one described as typical for the Mansker series. On about half the acreage, the surface layer consists of 5 inches of brown, calcareous clay loam. The surface layer is underlain by brown, calcareous clay loam about 7 inches thick. The other half of the acreage of this soil has a surface layer as much as 8 inches thick, but in a few areas the entire surface layer has been removed by erosion.

Erosion has reduced the rate of water intake in this Mansker soil. Available water capacity is low. Water runs

off in large amounts and deep gullies have been cut in sloping areas. Also, the lime content makes the surface fluffy, crumbly, and more susceptible to blowing.

Cultivated crops are not suited, but this soil is farmed with adjoining soils that are less sloping and more productive. Native grass has been reestablished in some areas. (Dryland capability unit VIe–1; Hardland Slopes range site)

Mansker clay loam, 5 to 8 percent slopes (MkD).—This soil occurs mostly along the Palo Duro and Tierra Blanca Creeks. A few narrow areas are on the south and southwest exposures of sloping rims of playas. This soil generally adjoins the Potter soil, which is above and adjacent to the caliche escarpment. Dominant slopes are about 7 percent, but in included areas slopes are as much as 10 percent. The surface is strongly convex.

The surface layer is brown to grayish-brown, calcareous clay loam about 7 inches thick. The subsoil is moderately permeable limy clay loam about 6 inches thick.

Included in the mapping were small areas of Potter soils. Also included are outcrops of caliche on the more exposed and stronger slopes. The included areas make up about 20 percent of the areas mapped.

This Mansker soil takes in water well, but its available water capacity is low.

Because caliche is near the surface, cultivated crops are not suited. All the acreage is in native grass, such as buffalograss and various kinds of gramas. A scattering of catclaw shrubs and forbs and patches of snakeweed also occur. (Dryland capability unit VIe–1; Hardland Slopes range site)

Mobeetie Series

The Mobeetie series consists of gently sloping to strongly sloping, calcareous, grayish-brown, loamy soils on foot slopes of uplands. These soils are moderately deep over caliche. They formed under native grasses in calcareous colluvium or local alluvium that originated in the High Plains. Soil development has been restricted to a slight movement of lime from the surface soil into the subsoil. Mobeetie soils occur in areas between the escarpments, some of them subdued, and the bottom lands along Tierra Blanca and Palo Duro Creeks.

In most areas the surface is strongly concave. Slopes range from 3 to 12 percent, though there are a few, small, receding catsteps or scarps. These scarps range from less than 1 foot to as much as 4 feet in thickness, but in most places they are about 2 feet thick.

In a typical profile, the surface layer is grayish-brown, friable fine sandy loam about 10 inches thick. The subsoil extends to a depth of 52 inches or more. It is grayish-brown fine sandy loam in the upper part and light brownish-gray sandy clay loam in the lower part.

Mobeetie soils make up some of the best rangeland in the county. Cultivated crops are not suited, because gullying and soil blowing are likely.

Typical profile of a Mobeetie fine sandy loam (800 feet west and 25 feet north of the southwest corner of section 2, block 5, H. & G.N. Railroad Survey; or 820 feet west of U.S. Highway No. 87, about 50 feet north of Hunsley Road) on a concave foot slope:

A—0 to 10 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 3.5/2) when moist; weak, fine and medium, granular structure that grades to coarse prismatic in lower part; soft when dry, very friable when moist; porous; many grass roots; many worm casts; a few medium-sized, strongly cemented, nodular concretions of calcium carbonate from caliche outcrops or shallow soils upslope; calcareous; moderately alkaline; gradual boundary.

B2—10 to 28 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, very coarse, prismatic structure that easily breaks to granular; many worm casts; slightly hard when dry, friable when moist; porous; many fine- and medium-sized old root channels, some lined with false mycelia of calcium carbonate; threads and specks of calcium carbonate common at top of layer to many on vertical walls of peds in lower part of horizon; most weakly cemented calcium carbonate concretions are fine and a few are medium; calcareous; mildly alkaline; gradual boundary.

B3ca—28 to 52 inches +, light brownish-gray (10YR 6/2) sandy clay loam, dark grayish brown (10YR 4/2) when moist; weak, very coarse, prismatic structure; soft when dry, very friable when moist; porous; many, fine, old root channels; many worm casts in upper part but these decrease with depth; fine- and medium-sized, strongly cemented concretions of calcium carbonate make up about 4 percent, by volume; calcareous; moderately alkaline.

The A horizon ranges from 6 to 14 inches in thickness and from brown or grayish brown to light grayish brown in hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 or 3. Structure is weak, fine to medium, granular, and texture ranges from light loam to fine sandy loam.

The B2 horizon ranges from 7 to 20 inches or more in thickness. From 1 to 8 percent of the soil mass consists of fine to coarse, nodular concretions of calcium carbonate from Potter and Mansker soils upslope. The amount of these concretions normally increases as the slope increases. The B3ca horizon is generally weakly defined and does not occur in some places.

The C horizon, which normally is at a depth of more than 52 inches, consists of colluvium and local alluvium in a layer ranging from 2 to 10 feet or more in thickness. It is underlain by residual Ogallala material.

The Mobeetie soils have similar horizonation to that of Berda soils, but they contain less clay throughout the solum and are less permeable. Mobeetie soils lack the distinct lime layers in the subsoil of the Mansker soils.

Mobeetie fine sandy loam, 3 to 5 percent slopes (MrC).—This soil occurs on the foot slopes of the Palo Duro Valley and in draws. Most slopes are about 4 percent. The surface is moderately concave or plane.

The surface layer is grayish-brown, very friable, granular fine sandy loam about 10 inches thick. It contains a moderate amount of free, unleached lime. The subsoil is friable and moderately rapidly permeable. It consists of limy fine sandy loam to loam about 15 inches thick. The underlying material is lighter colored, calcareous local alluvium overlying Ogallala material.

Included in mapping were small areas or bands that are transitional to Mansker clay loam and are mostly on the upper parts of slopes. Also included are areas of Berda clay loam on the lower slope. These inclusions make up less than 10 percent of any area mapped.

Available water capacity is low to moderately low, but this soil absorbs water readily.

All of this soil is native range, and no water is available for irrigation. This soil is very susceptible to blowing and gullying if tilled or overgrazed. If well managed, this soil is among the best soils in the county for native range. (Dryland capability unit IVe–5; Mixedland Slopes range site)

Mobeetie fine sandy loam, 5 to 12 percent slopes (MrD).—This soil occupies the foot slopes of the Palo Duro

Canyon, tributary canyons, and draws. Slopes are dominantly about 10 percent. The surface is mostly strongly concave, but it is plane or slightly concave in a few places.

The surface layer is grayish-brown to light brownish-gray fine sandy loam about 8 inches thick. About 5 percent of the profile consists of fine to coarse, strongly cemented, nodular caliche concretions from Potter and Mansker soils upslope. Depth to the calcareous underlying material is about 22 inches.

Included with this soil in mapping were small areas of Potter soils and of Rough broken land consisting of caliche outcrops near the escarpments. Also included were a few eroded spots of Mobeetie soils that have a thin mantle of caliche concretions. The included areas total about 15 percent of the areas mapped.

This Mobeetie soil takes in water readily, but natural fertility and available water capacity are moderately low.

This soil is used for native range. It supports moderately dense stands of mid grasses and some short and tall grasses and forbs. (Dryland capability unit VIe-2; Mixedland Slopes range site)

Olton Series

In the Olton series are deep, dark-brown, nearly level to moderately sloping soils on uplands. These soils occur within broader areas of Pullman soils and in bands of irregular width on the upper side slopes of playas and draws. Olton soils formed from deposits of loess from the High Plains. These deposits are older and coarser textured than those in which the closely associated Pullman soils formed. Slopes are single and smooth, and the surface is convex.

In a typical profile, the surface layer of Olton soils is neutral, dark-brown clay loam about 8 inches thick. The subsoil is clay loam that extends to a depth of about 48 inches. It is very hard when dry. The subsoil is dark brown in the upper part and reddish brown in the middle and lower parts. The underlying material extends to a depth of more than 96 inches and is pinkish-white clay loam in the upper part.

Natural fertility is high, and drainage is good. Cultivated crops and range are the main uses.

Typical profile of an Olton clay loam (about 2,600 feet south and 1,675 feet west of the northeast corner of section 7, block B-5, H. & G.N. Railroad Survey; or about 3.2 miles west and 1.5 miles north of Canyon) in a pasture of native grass:

A1—0 to 8 inches, dark-brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; weak, thin, platy structure in upper three-fourths inch and moderate, medium, granular and subangular blocky structure below; slight compaction or hoof pan to the depth of 3 inches; hard when dry, friable when moist; many, fine, fibrous roots; fine pores, channels, and worm casts common; neutral; gradual boundary.

B21t—8 to 15 inches, dark-brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; compound moderate, fine and medium, subangular blocky and blocky structure; very hard when dry, firm when moist, sticky when wet; roots common and generally follow between peds, but some penetrate the peds; fewer, fine biological pores and channels than horizon above; few worm and insect channels filled with casts; thin clay films continuous on ped surfaces; neutral; gradual boundary.

B22t—15 to 31 inches, reddish-brown (5YR 5/4) heavy clay loam, reddish brown (5YR 4/4) when moist; moderate, medium, blocky structure; very hard when dry, firm when moist, sticky when wet; peds coated with thicker continuous clay films than horizon above; a few worm channels filled with casts; roots are mostly between peds and are fewer than in horizon above; fine and very fine old root channels common; neutral in upper part of horizon and moderately alkaline in lower part; calcareous in lower half; gradual boundary.

B3ca—31 to 48 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) when moist; moderate, medium and coarse, blocky and subangular blocky structure; very hard when dry and less firm when moist than horizon above; sticky when wet; some thin, patchy clay films; few roots and worm channels and nests filled with casts; fine old pores and root channels common; calcium carbonate in threads and films, mostly between peds; few limy films in upper part and many in lower part of horizon; moderately alkaline; calcareous; clear boundary.

C1ca—48 to 68 inches, pinkish-white (5YR 8/2) clay loam, light reddish brown (5YR 6/4) when moist; weak, coarse, blocky and subangular blocky structure; hard when dry and less sticky when wet than horizon above; few fine roots; about 35 percent, by volume, is weakly and strongly cemented calcium carbonate concretions ¼ to 2 inches in diameter; rest of the volume has many, fine, old root channels; calcareous; moderately alkaline; gradual boundary.

C2—68 to 96 inches +, pink (5YR 7/4) clay loam, yellowish red (5YR 6/6) when moist; massive; hard when dry, friable when moist, slightly sticky when wet; about 15 percent, by volume, is weakly cemented to strongly cemented concretions of calcium carbonate in scattered pockets and masses; these decrease in number with depth; rest of material contains many fine and very fine old root channels and pores; calcareous moderately alkaline.

The A horizon ranges from 7 to 12 inches in thickness. Its texture ranges from loam to clay loam. Color is dark brown to dark reddish brown in hue of 7.5YR or 5YR. Value is 4 or 5 when the A horizon is dry, and value is 3 or 4 when this horizon is moist. Chroma is 2 or 3. Structure is weak or moderate, fine and medium, subangular blocky and granular.

The B2t horizon ranges from 14 to 42 inches in thickness. It ranges from clay loam to heavy clay loam, and it has weak or moderate, fine to medium, granular and blocky structure. Clay films on surfaces of peds are patchy in the upper part and continuous in the lower part of this horizon. Earthworm channels and nests are somewhat common in the upper part but are few in the lower part. The B3ca horizon ranges from 15 to 20 inches in thickness and from clay loam to heavy clay loam in texture. It is mostly reddish brown, but color ranges from reddish brown to brown in hue of 5YR or 7.5YR. Structure is weak or moderate, medium to coarse, blocky and subangular blocky. Fine to very fine, old root channels and pores are common throughout the horizon.

The C1ca horizon is 30 to 65 inches below the surface. It consists of pink to pinkish-white, calcareous, moderately alkaline material. The C1ca horizon ranges from 10 to 30 inches in thickness. From 10 to 15 percent of the volume is visible calcium carbonate that is weakly cemented. The C2 horizon is pink to reddish-yellow, calcareous, alkaline material.

The horizonation of the Olton soils is similar to that of the Pullman soils, but these soils are redder, less clayey, and more permeable. Their subsoil is more clayey and less permeable than that of the Amarillo soils. Olton soils show more horizonation and are deeper than the Zita or Ulysses soils.

Olton clay loam, 0 to 1 percent slopes (OcA).—This soil occupies smooth slopes within much larger areas of Pullman clay loam, 0 to 1 percent slopes, and between the Pullman clay loam and Acuff loam, 0 to 1 percent slopes. Most of this soil occurs in an area about 5 miles wide between Palo Duro Canyon and Buffalo Lake. The areas are gen-

erally 60 to 250 acres in size and are curvilinear in shape. The surface is plane or weakly convex.

Except that the surface layer is slightly thicker, this soil has a profile like the one described for the Olton series. The surface layer is neutral, dark-brown clay loam about 9 inches thick (fig. 10). The subsoil is about 42 inches thick. In the upper part of the next layer is a zone of accumulated lime that is strongly developed and pink to pinkish white. The rest of the layer is pink to reddish-yellow, limy material.

Included with this soil in mapping were areas of Pullman clay loam and Acuff loam, normally less than 5 acres in size. These inclusions require about the same treatment as the Olton soils.

This Olton soil absorbs water moderately slowly, but its available water capacity and natural fertility are high. It is easy to work.

About half the acreage is cultivated, and the rest is still in native grass. All the cropland is dryfarmed, mainly to winter wheat and grain sorghum. Crop growth is good when moisture is favorable, or when the soil is irrigated and well managed. Native grasses are chiefly blue grama and buffalograss. In tilled or overgrazed areas, the risk of soil blowing is slight. (Dryland capability unit IIIce–2; irrigated, I–1; Deep Hardland range site)

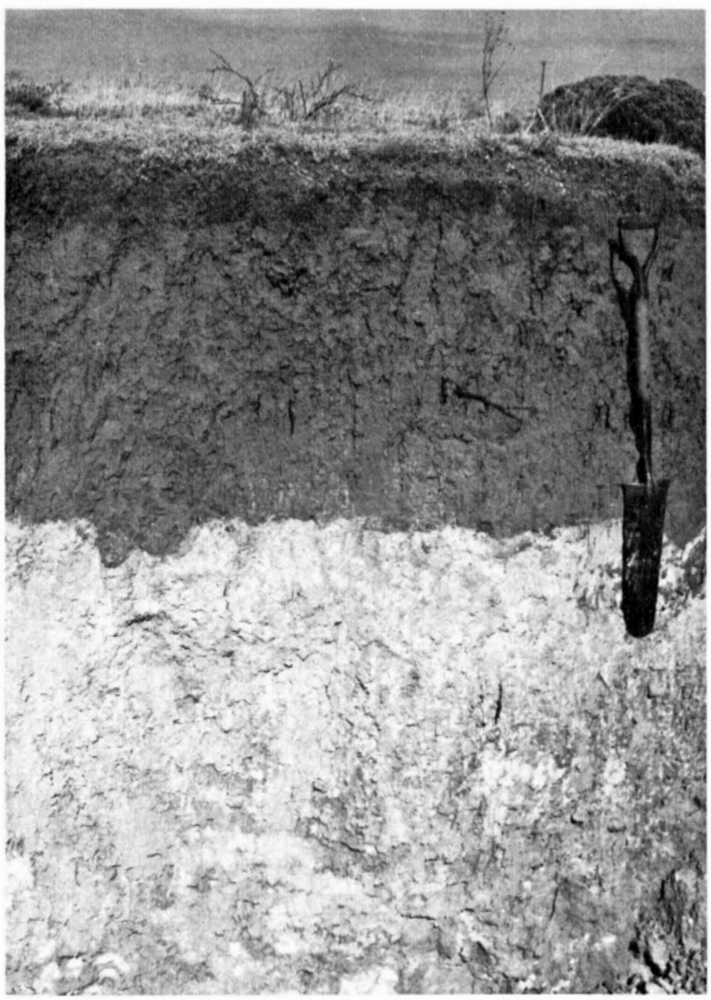

Figure 10.—**Profile of Olton clay loam. The light layer is the zone of lime accumulation.**

Olton clay loam, 1 to 3 percent slopes (OcB).—This soil occurs on slopes near draws and some of the rims of the larger playas in the county. Most areas range from 60 to 200 acres in size. Slope is dominantly about 2 percent, and the surface is convex or plane.

The surface layer is neutral, dark-brown clay loam about 8 inches thick. The subsoil is dark-brown to reddish-brown clay loam about 35 inches thick. The subsoil has a few limy threads, films, and weakly cemented concretions of calcium carbonate in the lower part. In the upper part of the underlying material is a prominent, pinkish-white layer of accumulated lime about 20 inches thick. Below this layer is pink, massive clay loam.

Included with this soil in mapping were narrow areas of a soil that is transitional to the adjoining Pullman clay loam. These included areas require about the same management as this Olton soil.

This soil is easy to till. It takes in water slowly, but available water capacity and natural fertility are high.

About one-fourth of this soil is cultivated, and the rest is rangeland. All of the cultivated acreage is dryfarmed, mainly to grain sorghum and winter wheat. When the content of moisture is favorable and management is good, dryfarmed crops grow well. Careful management is particularly needed in sloping areas, where susceptibility to water erosion is moderate. Damage from soil blowing is only slight. (Dryland capability unit IIIe–2; irrigated, IIe–2; Deep Hardland range site)

Olton clay loam, 3 to 5 percent slopes (OcC).—This soil is on the side slopes of draws and the rims around the larger playas in the county. Most areas average about 60 acres in size. Areas are normally in bands that follow the relief of the landscape and are somewhat irregular in width. Slopes range from 3 to 5 percent, but in included areas are as much as 6 percent. The surface is strongly convex.

The surface layer is brown to dark-brown clay loam about 7 inches thick. The subsoil is moderately slowly permeable, reddish-brown clay loam about 30 inches thick. In the upper part of the underlying material is a layer of pinkish-white accumulated lime about 18 inches thick. The rest of the layer is pink, massive clay loam.

Included in mapped areas were a few small areas that are transitional to Acuff loam and a few spots of Ulysses clay loam. Ulysses clay loam is more susceptible to blowing that the other soils, and it may require more intensive management.

This Olton soil is fertile and somewhat easy to till, but it takes in water moderately slowly. Available water capacity and fertility are moderately high.

This soil is used mainly as range, but a few small fields are dryfarmed, mainly to sorghums. Mesquite is common in heavily grazed areas. (Dryland capability unit IVe–1; irrigated, IIIe–2; Deep Hardland range site)

Potter Series

The Potter series consists of strongly sloping to steep, calcareous, grayish-brown soils that occur on uplands and have a gravelly loam or loam surface layer. In most places these soils are directly above the escarpments bordering the High Plains. They are very shallow over caliche. Potter

soils formed over caliche and calcareous soil material that probably formed during the Pleistocene epoch when underground water enriched the deposits with lime.

In a typical profile, the surface layer of Potter soils is grayish-brown, friable gravelly loam about 9 inches thick. It is underlain by light-gray, strongly cemented to weakly cemented caliche that is more weakly cemented and more interspersed with calcareous, pinkish material as depth increases. This layer extends to a depth of 40 inches or more.

Runoff is moderate to rapid, and geologic erosion is active on most areas.

These soils are not suitable for cultivation, but they support weak to sparse stands of grasses, forbs, and shrubs that require little water. Use for range and as wildlife habitat is small. In accessible areas caliche is quarried and used locally as a base for roads. Also, cement is manufactured from the caliche and calcareous soil materials.

Typical profile of a Potter soil that has a gravelly loam surface layer (near the escarpment of the Palo Duro Draw in the southwest corner of section 12, block 6, I. & G.N. Railroad Survey; or about 5 miles east and 5 miles north of Canyon):

A1—0 to 9 inches, grayish-brown (10YR 5/2) gravelly loam, dark grayish brown (10YR 4/2) when moist; weak and moderate, fine, granular structure; slightly hard when dry, friable when moist; many worm casts in lower two-thirds of horizon; about 25 percent, by volume, is weakly and strongly cemented caliche concretions and fragments; calcareous; moderately alkaline; clear boundary.

Cca—9 to 40 inches +, light-gray (10YR 7/2) caliche that is strongly cemented in upper part but weakly cemented and more interspersed with calcareous pinkish material as depth increases.

The A horizon ranges from 2 to 10 inches in thickness. The average thickness is about 6 inches. When the A horizon is dry, color ranges from pale brown or light brownish gray to dark grayish brown in hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2. Texture is gravelly loam to loam. Weakly to strongly cemented concretions and weathered fragments of caliche make up about 10 to 35 percent of the A horizon, by volume.

The Cca horizon ranges from light gray to pinkish white in color and from a few to many feet in thickness. Strongly cemented to weakly cemented caliche makes up about 60 to 90 percent of the layer. The rest of the layer is calcareous and alkaline material that contains many, fine, old root channels and some roots and worm casts. The biological activities in the soil decrease rapidly with depth.

The Potter soils are somewhat similar to the Mansker soils but are more sloping, are shallower to caliche, and contain more lime. They are more gravelly and limy throughout the solum than the associated Kimbrough soils and have a softer caliche substratum that is largely weakly cemented.

Potter soils (Pe).—These soils are very shallow over caliche. They are along the steeper rims of draws and canyons in the county. The areas are long and range from 30 to 300 acres in size. Dominant slopes are strong to steep, but a few areas are gently sloping.

These soils have a grayish-brown loam to gravelly loam surface layer that is about 7 inches thick and is underlain by thick caliche (fig. 11).

Available water capacity is low, and the hazards of washing, blowing, and gullying are severe in unprotected areas.

Included with these soils in mapping were a few gently sloping to moderately sloping spots of Kimbrough-Lea loams, Mansker clay loam, Berda loam, and Mobeetie fine sandy loam, each less than 20 acres in size. These

Figure 11.—**Profile of Potter soils. The light layer consists mostly of hard caliche pebbles.**

included areas make up about 20 percent of the mapping unit

Potter soils are suitable only as range or wildlife habitat. (Dryland capability unit VIIs–1; Very Shallow range site)

Pullman Series

The Pullman series consists of dark-colored, nearly level to gently sloping, loamy soils on uplands. These soils are generally well drained, but they are slowly permeable when moist and very slowly permeable when dry. They developed on the fine textured and moderately fine textured, calcareous loessal sediments that mantle the High Plains. Climate is relatively cool, and the native vegetation is short grasses. Areas of these soils are dotted with depressions or playas containing other soils. Near the draws and the larger playas slopes range from 0 to 3 percent, but typically slopes are less than 0.3 percent.

In a typical profile, the surface layer of Pullman soils is neutral, dark grayish-brown clay loam about 6 inches thick. It is underlain by a clay and clay loam subsoil

that extends to a depth of about 62 inches and is blocky when dry. It is dark grayish brown in the upper part, brown in the middle part, and reddish brown in the lower part. Calcium carbonate has accumulated between depths of about 33 and 46 inches. The underlying material extends to a depth of more than 90 inches and is pink, calcareous clay loam in the upper part.

Typical profile of a Pullman clay loam (approximately 150 feet south of the county road and 450 feet east of the southwest corner of section 197, block 9, B.S. & F. Survey) in a native pasture:

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; compound moderate, medium, granular and subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; many, fine, fibrous roots; fine and medium pores common; neutral; clear boundary.

B21t—6 to 15 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium, blocky structure when dry but massive when wet; extremely hard when dry, very firm when moist, sticky when wet; few fine roots, mostly between peds, are flattened; ped surfaces shiny; horizontal surfaces of peds smoother than vertical surfaces, which are microknobby; some pressure faces, tilted 10 to 15 degrees from horizontal, in lower part of horizon; horizon is slightly less clayey than underlying horizon; neutral; gradual boundary.

B22t—15 to 33 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; strong, medium, blocky structure when dry, but massive when wet; extremely hard when dry, very firm when moist, sticky and plastic when wet; some wedge-shaped slickenside peds; shape of peds caused by common, shiny, smooth pressure faces tilted 10 to 15 degrees from the horizontal; horizontal axis of peds are longer than vertical; few, very fine, old root channels are in lower part, but fine fibrous roots are fewer than in horizon above and are compressed between peds; neutral in upper part of horizon and mildly alkaline in lower part; clear boundary.

B2b1—33 to 46 inches, brown (10YR 5/3) light clay, dark brown (10YR 4/3) when moist; moderate to strong, medium, blocky structure; very hard when dry, firm when moist, sticky and plastic when dry; continuous shiny surfaces on peds; calcium carbonate common in threads, films, and fine segregations; calcareous; moderately alkaline; abrupt boundary.

B2b2—46 to 62 inches, reddish-brown (5YR 5/4) heavy clay loam, reddish brown (5YR 4/4) when moist; moderate, medium and coarse, blocky structure; very hard when dry, firm when moist, sticky when wet; vertical surfaces of peds somewhat knobby; continuous shiny surfaces of peds; few roots between peds but some through them; vertical axis of peds slightly longer than horizontal; threads of lime fill some very fine root channels in the lower part of horizon; calcium carbonate films common between vertical walls of peds, but interior of peds is neutral; abrupt boundary.

C1cab—62 to 76 inches, pink (5YR 8/3) clay loam, light brown (5YR 6/3) when moist; structureless (massive); very hard when dry, friable when moist, slightly sticky when wet; about 60 percent, by volume, is mostly massive chalky concretions; very fine old root channels common; calcareous; moderately alkaline; gradual boundary.

C2b—76 to 90 inches +, light reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 5/4) when moist; structureless (massive); very hard when dry, friable when moist, and slightly sticky when wet; scattered small pockets of calcium carbonate concretions are mostly weakly cemented but partly strongly cemented; very fine old root channels common.

The A horizon ranges from 4 to 8 inches in thickness but is mostly 6 inches thick. The difference in thickness is partly the result of soil blowing, water erosion, or both. Color is dark grayish brown to dark brown in a hue that is dominantly 10YR but ranges to 7.5YR. Value is 4 or 5 when the A horizon is dry, and value is 3 when this horizon is moist. Chroma is 2. Texture ranges from light clay loam to silty clay loam. On rangeland near cultivated areas, as much as 2 inches of loam and silt loam have been deposited by wind and water.

The B2t horizon ranges from 15 to 56 inches in thickness. It has moderate to strong, medium, blocky structure. Pressure faces on wedge-shaped peds range from few in upper part to common in lower part of the B2t horizon. This horizon ranges from reddish brown to yellowish red. It is mostly neutral, but the surface of the peds is calacareous in places. The B2b horizon is moderate, medium to coarse, blocky clay loam to heavy clay loam in some places.

The C1cab horizon is 25 to 70 inches below the surface.

The Pullman soils are less clayey than the lower lying Roscoe or Randall soils and are better drained and show more horizonation. Also, Pullman soils are leached of lime in the upper layers. Their subsoil is more clayey, more compact, and less permeable than that in the associated Olton soils. Pullman soils are lighter colored throughout the solum than Lofton clay loam in depressions. They are deeper, darker, show more horizonation, and contain more clay than the Ulysses soils, which are calcareous throughout the solum.

Pullman clay loam, 0 to 1 percent slopes (PmA).—This is the most extensive soil in the county and the most important for farming. It is dominant in the High Plains and surrounds the playas and the nearly level to gently sloping Ulysses and Zita soils and the more sloping and shallower Pullman soils. This soil slopes eastward at a gradient of mostly less than 0.3 percent.

The surface layer is neutral, dark grayish-brown, friable clay loam about 6 inches thick. It tends to be lighter in texture in the western part of the county, where normal rainfall is less than in the eastern part and soil blowing is more hazardous. Most areas of this soil that were cultivated in the 1930's probably lost as much as 2 inches of their surface layer through soil blowing. Because runoff is slow, there has been little or no damage by water erosion in most areas.

The subsoil is about 45 inches thick. The upper layer is neutral, dark grayish-brown clay. The middle layer is brown, compact clay. It is generally neutral and is the least permeable layer in the subsoil. Fine fibrous roots are fewer than in the surface layer and are compressed between the structural blocks. The lower layer in the subsoil is brown, limy, blocky light clay that is less compact than the middle layer. The upper part of the loamy substratum has a pink or pinkish-white lime layer. Figure 12 shows the entire profile of this soil and a part of the subsoil.

Included with this soil were small areas of Ulysses, Olton, and Zita clay loams. Also included are soils, mostly Randall clay, in scattered, small, circular depressions that are less than 5 acres in size. Randall clay remains wet longer than the surrounding Pullman soil. Included areas of Olton and Randall soils do not appreciably affect management, but the Ulysses and Zita soils may require special practices since soil blowing is a hazard.

This droughty Pullman soil takes in water slowly but has high available water capacity. Its natural fertility is also high. If management is good and moisture content optimum, cultivated crops grow well. This soil is easily worked within a moderate range of moisture content. Excessive tillage, however, destroys the desirable structure, powders the soil, and makes it susceptible to blowing. A

plowsole tends to form if this soil is tilled when it is too wet, or is repeatedly tilled to the same depth. The plowsole hinders growth of roots and absorption of moisture.

About 80 percent of the acreage is cultivated. About two-thirds of the cultivated acreage is dryfarmed, and one-third is irrigated. The remaining acreage is rangeland in short grasses. (Dryland capability unit IIIce-1; irrigated, IIs-1; Deep Hardland range site)

Pullman clay loam, 1 to 3 percent slopes (PmB).—This soil is extensive and important to farming. It occurs in bands that surround the larger playas and on the weaker side slopes of draws. Dominantly slopes are about 2 percent, but in included areas slopes are as much as 4 percent. The surface of the soil is plane or convex.

The surface layer is neutral, dark grayish-brown, friable clay loam about 5 inches thick. Most areas that have been tilled for some time have lost as much as 3 inches of the surface layer through water erosion and soil blowing.

The subsoil is about 40 inches thick. Depth to free lime ranges from 15 to 25 inches, and depth to the zone of accumulated lime is about 45 inches.

Included with this soil were small elongated areas of Ulysses and Olton clay loams. Also included are a few eroded spots of Pullman clay loam that require special treatment. Ulysses clay loam tends to blow easier than this Pullman soil and requires more management, but Olton clay loam responds to about the same management.

This droughty Pullman soil takes in water slowly, but its fertility and available water capacity are high. It can be worked throughout a moderate range of moisture content.

About three-fourths of the acreage is cultivated, and the rest is used as native short-grass range. About 80 percent of the cultivated acreage is dryfarmed, and 20 percent is irrigated. When the content of moisture is favorable and the soil is properly managed, crops grow well under dryfarming. Crop growth is good to excellent under irrigation and good management. (Dryland and irrigated capability units IIIe-1; Deep Hardland range site)

Pullman clay loam, 1 to 3 percent slopes, eroded (PmB2).—This eroded soil is on ridges and at heads of small draws in cultivated fields from which water drains into the playas and draws of the High Plains. Most areas are about 20 acres in size. Most slopes are about 3 percent, but in some included areas slopes are as much as 4 percent. The surface is convex and in places is gullied.

The surface layer is neutral, dark-brown to dark grayish-brown clay loam that ranges from 1 to 5 inches in thickness but has an average thickness of about 3 inches. About half of the surface layer has been removed, mainly by sheet erosion. In places tillage has made the surface layer more clayey by mixing into it some of the upper part of the clay subsoil. The surface layer, therefore, crusts more easily and slows the rate of water intake. Droughtiness and susceptibility to erosion increase. Where loss of original surface layer has been excessive, the organic-matter content and the natural fertility have been reduced. This soil has moderate to moderately high available moisture capacity and fertility. Shallow, crossable gullies are

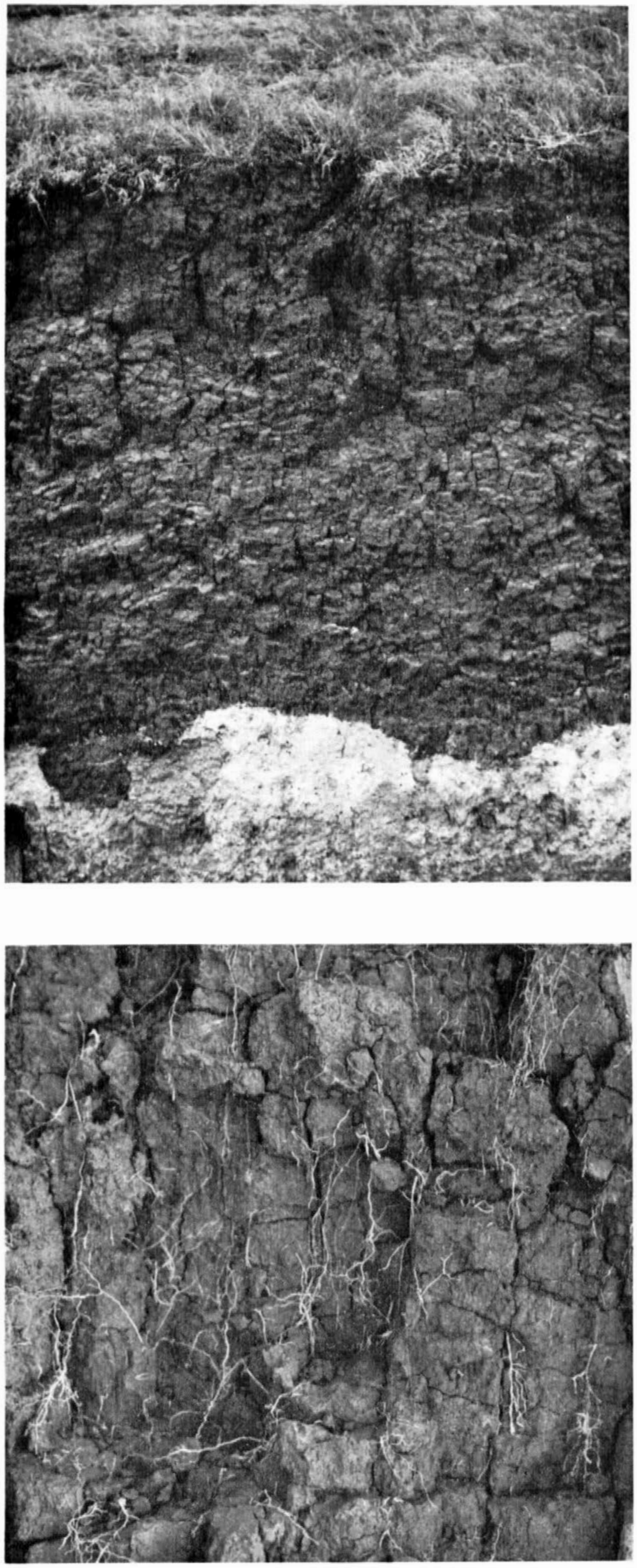

Figure 12.—**Pullman clay loam, 0 to 1 percent slopes. *Top:* Profile shows a subsoil with strong blocky structure and shrinkage cracks that extend to a layer of accumulated calcium carbonate. *Bottom:* Part of the subsoil (B22t horizon) in which most roots are between the blocky peds and are flattened.**

common, but gullies have cut deeply into the underlying material in a few places.

Included in mapping were some small areas of eroded Ulysses soils that are more susceptible to blowing than this eroded Pullman soil and require special treatment that minimizes further damage.

Because this eroded Pullman soil occurs within larger cultivated fields of Pullman soils, most of it is cultivated. (Dryland capability unit IVe–3; irrigated, IIIe–2; Deep Hardland range site)

Pullman clay loam, moderately shallow, 0 to 1 percent slopes (PuA).—This soil is mostly on flats. Most areas are irregular to curvilinear in shape and average about 120 acres in size. Slope is dominantly about 0.5 percent, though the range is from 0 to 1 percent.

Most areas of this soil that were cultivated in the 1930's probably lost about 2 inches of their surface layer through soil blowing. The surface layer now is dark grayish-brown, friable clay loam about 5 inches thick. The subsoil is dark grayish-brown to brown clay or silty clay. Depth to free lime is about 15 inches, and the layer of accumulated lime occurs at a depth of about 30 inches.

Included with this soil in mapping were small areas of Olton clay loam 3 to 20 acres in size and small, scattered areas of Ulysses and Zita clay loams. Also included were a few, small areas of Randall clay in depressions that remain wet longer than the surrounding Pullman soils. The included areas of Olton and Randall soils do not appreciably affect management, but the Ulysses and Zita soils may require special practices, since soil blowing is more likely than on the other soils in this unit.

This Pullman soil takes water slowly, but its available water capacity and natural fertility are high. Cultivated crops grow well if management is good and moisture content is optimum. This soil is easy to work throughout a moderate range of moisture content. Because excessive tillage has destroyed the granular structure in some areas, the soil powders and is susceptible to blowing. Also, a plowsole is likely to form if this soil is tilled when it is too wet, or is repeatedly tilled to the same depth. The plowsole limits growth of roots and absorption of moisture.

Slightly more than half the acreage is cultivated, and the rest is still in native range. About two-thirds of the cultivated acreage is dryfarmed, and one-third is irrigated. (Dryland capability unit IIIce–1; irrigated, IIs–1; Deep Hardland range site)

Pullman clay loam, moderately shallow, 1 to 3 percent slopes (PuB).—This soil occurs in some of the areas around playas and along draws on the High Plains. Most areas are about 45 acres in size, and the total acreage in the county is small. Most slopes are 2.5 percent, but in some included areas slopes range up to 4 percent. The surface is plane or convex.

The surface layer is neutral, grayish-brown clay loam about 4 to 5 inches thick. Because of slope and lack of cover, about 2 inches of the surface layer has been removed by sheet erosion. The subsoil is similar to that of Pullman clay loam, 1 to 3 percent slopes, but it is thinner and slightly more permeable. Depth to free lime is about 12 inches, and depth to the layer of accumulated lime is about 26 inches.

Included with this soil in mapping were areas of Olton clay loam 3 to 15 acres in size and some spots and narrow areas that are transitional to areas to Ulysses clay loam. The Olton soil responds to about the same management as this Pullman soil, but the Ulysses soil may need special treatment since it is subject to blowing.

This droughty Pullman soil takes water slowly, but its fertility and available moisture capacity are high. Crops grow well if management is good and the moisture content optimum. This soil is easily worked throughout a moderate range of moisture content. In sloping and exposed areas, water erosion is moderately severe and soil blowing is moderate.

A little more than half of the acreage is cultivated, and the remaining acreage is still in native range. About two-thirds of the cultivated acreage is dryfarmed, and one-third is irrigated. (Dryland and irrigated capability units IIIe–1; Deep Hardland range site)

Quinlan Series

The Quinlan series consists of shallow soils that have a reddish-brown very fine sandy loam surface layer. These soils developed in the lower part of the Palo Duro Canyon on soft, reddish, weakly consolidated sandstone or packed sand, mostly of Permian origin. The native vegetation was grasses. Slopes range from 5 to 30 percent.

In a typical profile, the surface layer of these soils is calcareous, reddish-brown very fine sandy loam about 6 inches thick. The next layer is also reddish-brown very fine sandy loam about 6 inches thick, but in it weathered flakes of shale are common. It is underlain by reddish-brown, weakly cemented sandstone that extends to a depth of 18 inches or more.

Quinlan soils are used only for limited grazing for livestock and as wildlife habitat. Vegetation is dominantly a sparse cover of grasses, consisting chiefly of gramas, bluestems, and dropseeds, though a scattering of dwarfed juniper and mesquite shrubs grow on the deeper soils.

Typical profile of a Quinlan soil that has a very fine sandy loam surface layer (in the Palo Duro State Park, about 200 feet northeast of Sad Monkey Tourist Railroad Depot, on east side of Park Road 5):

A1—0 to 6 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak, fine, subangular blocky and granular structure; slightly hard when dry, very friable when moist; worm casts common; most roots occur in this layer; fine flecks of shale throughout; calcareous; clear boundary.

B&R—6 to 12 inches, reddish-brown (2.5YR 4/4) very fine sandy loam, dark reddish brown (2.5YR 3/4) when moist; weak granular structure; very friable when moist; few roots and worm casts; weathered flakes of shale common; gypsiferous; calcareous; clear boundary.

R—12 to 18 inches +, reddish-brown (2.5YR 5/4), medium, platy, weakly cemented sandstone, dark reddish brown (2.5YR 3/4) when moist; prominent, round, gray splotches throughout; a few roots between weathered plates in upper 4 to 6 inches; surfaces of plates gypsiferous; calcareous; interiors of plates are noncalcareous; mildly alkaline.

The A horizon ranges from 6 to 8 inches in thickness. When this horizon is dry, color ranges from light reddish brown or reddish brown to yellowish red in hue of 5YR or 2.5YR, value of 5, chroma of 4 to 6. In a few places texture ranges to fine sandy loam.

The B&R horizon ranges from reddish-brown (2.5YR 4/4) very fine sandy loam in the upper part to red (2.5YR 4/6) very fine sandy loam in the lower part.

The R horizon is weakly consolidated Permian sandstone that has red to dark-red lenses of gypsum and pockets of packed sand.

Quinlan soils have about the same depth as Potter soils but are sandier. Quinlan soils have a thinner solum than the Woodward soils.

Quinlan-Woodward complex (Qw).—This complex consists of shallow to moderately deep soils on uplands. Slopes range mainly between 5 and 30 percent. These soils formed in red beds and are closely intermingled with areas of Rough broken land. Areas of this complex are very irregular in shape and generally lie between the narrow bottom lands and the higher lying red beds of the Palo Duro Canyon.

In this complex Quinlan soil makes up about 40 percent of the acreage; Woodward soil, 35 percent; and other soils, 25 percent.

Included with these soils in mapping were areas of Rough broken land, small areas of shale and gypsum material, narrow bands of Broken alluvial land, and spots of badlands. The included areas make up about 25 percent of the complex.

The Quinlan soil has a reddish-brown very fine sandy loam surface layer about 8 inches thick. This layer is less red than the underlying platy or weakly cemented sandstone.

The Quinlan soil has low available moisture capacity and moderately low natural fertility. In sloping areas, runoff is rapid. This soil supports sparse stands of gramas, bluestems, and needlegrass, and a scattering of yucca and juniper.

The Woodward soil has a red very fine sandy loam surface layer about 10 inches thick. The subsoil is reddish-brown very fine sandy loam about 10 inches thick. It is underlain by very fine sandy loam that is darker red than the subsoil.

The Woodward soil is moderately sloping to sloping and is well drained. Surface runoff is slow to moderate. Water is taken into the soil readily, and available water capacity, natural fertility, and the content of organic matter are moderate. Growth of forage plants is better on this Woodward soil than on the other soils in the complex.

This complex is used only as range or wildlife habitat. (Dryland capability unit VIe-4; Mixedland range site)

Randall Series

The Randall series consists of deep, gray, poorly drained clays that are self mulching. These soils occupy the floor of depressions or playas, where they formed in calcareous, lacustrinelike clay sediment that was washed or blown from surrounding, higher lying soils. The native vegetation is aquatic plants.

In a typical profile, the surface layer extends to a depth of about 50 inches. It is neutral, gray clay that contains a few, shot-shaped concretions of ferromanganese. The underlying material is light-gray, stratified clay loam that extends to a depth of 110 inches or more.

Internal drainage is very slow. In most areas evaporation removes more water than penetrates the soil and enters the water table. Flooding is likely. The profile to a depth of about 50 inches is very sticky when wet and extremely hard when dry. Also, these soils crack deeply when they are dry.

Randall soils are not suitable for cultivation, but in some of the shallower playas they are cultivated if excess water is diverted. Even in these places, however, loss of some crops is likely during the wetter periods. During drier years, these soils are used mostly for temporary grazing. After rains, some of the playas collect water that is used for irrigation and by migratory ducks and geese as resting places.

Typical profile of Randall clay (in a large playa on the Southwestern Great Plains Field Station, 2,200 feet north and 75 feet east of the southwest corner of section 178, block 9, Beaty Seal & Forward Survey):

A11—0 to 22 inches, gray (10YR 5/1) heavy clay, very dark gray (10YR 3/1) when moist; moderate, fine, angular blocky and granular structure when dry but massive when wet; peds readily crumble to fine and very fine angular blocks that are easily shifted by wind where the surface lacks vegetative cover; extremely hard when dry, extremely firm when moist, very sticky and plastic when wet; few, fine to medium, hard, shot-shaped concretions of ferromanganese; sedge roots common; neutral; diffuse, smooth boundary.

A12—22 to 50 inches, gray (10YR 6/1) heavy clay, dark gray (10YR 4/1) when moist; moderate, medium, subangular blocky and angular blocky structure when dry but massive when wet; extremely hard when dry, extremely firm when moist, very sticky and plastic when wet; slickensides are few in upper part to common in lower part; few, fine to medium, hard, shot-shaped concretions of ferromanganese; sedge roots less common than in the horizon above and decrease in number with depth; neutral; gradual, smooth boundary.

C—50 to 110 inches +, light-gray (10YR 7/2), stratified clay loam, light brownish gray (10YR 6/2) when moist; weak angular blocky and platy structure; very hard when dry, firm when moist, sticky when wet; few, fine and medium, old root channels in upper part; calcareous; moderately alkaline.

The A11 horizon is dominantly clay, but in a few places the topmost 2 to 5 inches is grayish-brown silty clay to fine sandy loam that has washed or blown from surrounding cultivated soils. The A11 horizon ranges from 15 to 30 inches in thickness, and the A12 horizon ranges from 15 to 50 inches in thickness. The A12 horizon has weak to moderate, medium, angular blocky structure when dry and is massive when wet. Color value is about one Munsell notation lighter in the A12 horizon than in the A11.

Color of the A horizon ranges from gray to dark gray. Hue is dominantly 10YR but ranges to 2.5Y in the A11 and the A12 horizons. Value of the A12 horizon ranges from 4 to 6 when this horizon is dry and from 3 to 4 when it is wet. Chroma is 1. The solum is generally neutral and noncalcareous, but in places it is moderately alkaline and calcareous.

Depth to the C horizon ranges from 40 to 110 inches, but is about 50 to 60 inches in most places. The C horizon ranges from light gray to gray and is mottled with brown and yellow in most areas.

Randall soils are grayer, more clayey, and more poorly drained than the associated Roscoe soils. They are more clayey, much more poorly drained, and show less horizonation than the Lofton soils.

Randall clay (Ra).—This poorly drained soil occurs on floors of playas throughout the county. Most areas are circular and range from less than an acre to several hundred acres in size, but the average size is about 70 acres. This soil is level in most places, but on some outer rims slopes are as much as 2 percent. The surface of these rims is concave.

The topmost layer is gray to dark-gray, heavy, blocky soil material that ranges from 18 to 60 inches in thickness but is about 40 inches thick in most places. This layer is

generally clay but the topmost 2 to 5 inches is clay to fine sandy loam in recent windblown or waterlain deposits. Some faint mottles occur in the lower part of the surface layer and in the substratum. In some areas a slight swampy odor is evident. The substratum is light-gray, massive clay stratified with clay loam and loam at depths of more than 80 inches. This soil is very slowly permeable when wet. When it is dry, deep shrinkage cracks occur in a geometric pattern and extend downward to the substratum (fig. 13).

Included in mapping were a few, small areas of Roscoe clay; a few narrow, sloping bands of clayey material; and a few alkaline spots. Also included are a few, narrow bands of Randall clay that have an overburden of stratified silt, clay loam, or fine sandy loam 1 to 4 inches thick. The included areas total about 15 percent of most areas mapped.

Randall clay is fertile, but it takes water very slowly and is regularly ponded for periods ranging from a few days to months. Most of the water is removed by evaporation, for there is no surface drainage and internal drainage is very slow.

Figure 13.—**Profile of Randall clay. Shrinkage cracks extend deeply into the profile.**

This soil is generally not suitable for cultivation. Most of the acreage is used for temporary grazing when this soil is not ponded. Some areas are collecting basins for runoff water that is largely used for irrigation and watering livestock. During the long, rainy periods, drowning kills most of the native upland vegetation, mainly western wheatgrass, buffalograss, and saltgrass, but lake sedges and smartweeds grow well. Lake sedges provide good grazing for livestock and also furnish good food and some shelter for wild ducks and geese.

This soil is susceptible to blowing as soon as the ponded water dries up in the areas where the vegetation has drowned and can no longer protect the surface. Emergency tillage is commonly practiced so as to prevent the start of soil blowing that otherwise would spread to nearby cropland. (Dryland capability unit VIw-1; not assigned a range site.)

Roscoe Series

The Roscoe series consists of deep, moderately well drained, self-mulching clays in depressions or playas. These soils occur on the lowest benches of the larger playas in the county. They formed under short and mid grasses and perennial weeds in clayey, lacustrinelike sediment that washed from surrounding higher lying soils.

In a typical profile, the surface layer of these soils is calcareous, dark-gray clay about 32 inches thick. The next layer extends to a depth of 56 inches and consists of gray clay. Slickensides are common in the upper part of this layer. The underlying material is light-gray silty clay in which calcium carbonate has accumulated. This layer extends to a depth of 90 inches or more.

In areas of native grass, relief characteristically is micromounded and pitted because of the shrinking and swelling. When these soils are dry, they crack in a regular geometric pattern. The cracks are 2 to 3 feet deep and as much as 5 inches wide. Part of the air-slaked surface layer washes or falls into these cracks. When the soils are wetted, the cracks close, but when they dry again, more material from the surface layer falls into the cracks. Because of this movement of soil material, a very thick surface layer forms.

Surface drainage is slow, and at times it is lacking. Permeability is generally slow.

Roscoe soils are suitable for cultivation, but they are used mostly for range and as wildlife habitat. The acreage farmed to small grains is increasing, though a few crops have been lost by flooding during the rainier season.

Typical profile of Roscoe clay on a low playa terrace (2,050 feet south and 50 feet west of the northeast corner of section 29, block M-9, John H. Gibson Survey; or about 4 miles east and 1.5 miles north of Happy) native grass pasture:

A11—0 to 15 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3.5/1) when moist; upper 2 to 3 inches is weak, thin, platy accumulation, and rest is compound moderate, medium, subangular blocky and blocky structure when dry but massive when wet; few slickensides; very hard when dry, very firm when moist, very sticky and plastic when wet; many, fine, fibrous roots in upper part that are mostly flattened and follow between peds; calcareous; diffuse boundary.

A12—15 to 32 inches, dark-gray (10YR 4/1) heavy clay, very dark gray (10YR 3/1) when moist; compound moderate and strong, medium and coarse, angular blocky

structure when dry and massive when wet; common slickensides; continuous shiny surfaces on peds; extremely hard when dry, very firm when moist, very sticky and plastic when wet; few roots, nearly all of which are between peds and are flattened; prominent shrinkage cracks, 2 to 5 inches wide, become narrower as depth increases; few, fine- and medium-sized, hard, black, shot-shaped pellets, probably of iron or manganese; calcareous; moderately alkaline; gradual boundary.

AC—32 to 56 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; compound moderate, medium and coarse, blocky structure when dry and massive when wet; slickensides common in upper part; extremely hard when dry, extremely firm when moist, very sticky and plastic when wet; some tongues of dark material from A1 horizon extend downward through this horizon to the underlying C or Cca horizon; calcareous; moderately alkaline; gradual boundary.

C or Cca—56 to 90 inches +, light-gray (10YR 7/1) silty clay, light brownish gray (10YR 6/2) when moist; structureless (massive); very hard when dry, firm when moist, sticky when wet; about 15 to 20 percent, by volume, is scattered, fine and medium, weakly cemented concretions of calcium carbonate; rest is massive, pale-brown soil material; fine old root channels common; calcareous; moderately alkaline.

Texture of the A horizon is dominantly clay. Where these soils are adjacent to sloping, eroding, cultivated fields, 1 inch to 3 inches of weak platy overwash and windblown soil material have accumulated. Under native grass structure of the A horizon is compound moderate to strong, medium, subangular blocky and blocky when dry and massive when wet. The AC horizon is similar to the A horizon, except that it is lighter in color and has slightly weaker structure.

The C or Cca horizon is massive, light-gray silty clay several feet thick. The profile is usually moderately alkaline but the upper part is neutral in some places. Roscoe soils are normally calcareous throughout the profile, but in places they are noncalcareous to a depth of 15 inches.

Roscoe soils are darker, less clayey, and better drained than Randall soils. These soils show less distinct horizons and are grayer and more clayey than the Lofton and Pullman soils, which are free of lime in their upper horizons.

Roscoe clay (Rc).—This soil occurs on low benches in the larger playas throughout the High Plains. It is below Lofton clay loam and above Randall clay. Areas of Roscoe clay are crescent shaped or in concentric bands that range from 25 to 300 acres in size but are dominantly about 60 acres. The width of these areas generally varies.

Under native grass, this soil is almost level but has micromounds. The surface layer is dark-gray, calcareous clay that ranges from about 15 to 30 inches in thickness (fig. 14). In some places reaction is neutral. Below the surface layer is very sticky, calcareous, slowly permeable, blocky clay about 20 inches thick. It is underlain by calcareous, light-gray silty clay.

Mapped with this soil were areas of Randall clay in depressions and narrow, sloping bands. Also included were a few, small alkaline spots and a few small areas that are transitional to Lofton soils. The included areas make up as much as 15 percent of some areas mapped.

This deep, fertile, droughty soil is slowly permeable in the subsoil. Available water capacity and surface drainage are slow, and in places surface drainage is lacking. This soil can be worked within only a narrow range of moisture content. The surface crusts, slacks, and powders, and material blows easily if this soil is excessively tilled and left unprotected.

About one-third of this soil is in winter wheat and grain sorghum. Nine-tenths of this cultivated acreage is dryfarmed, and one-tenth is irrigated. The rest of this soil is in native grasses consisting chiefly of western wheatgrass, blue grama, and buffalograss. These grasses are in dense stands in most areas, but saltgrass is dominant on the included alkaline spots. (Dryland capability unit IIIce-1; irrigated, IIs-1; Deep Hardland range site)

Figure 14.—Profile of Roscoe clay.

Rough Broken Land

Rough broken land (Ro) occurs below the gently sloping soils of the High Plains. It is between the upper edge of the caliche escarpments and the lower lying erosional plains in the Palo Duro Canyon. Typical areas are the west or east steep walls of the Palo Duro Canyon within the Palo Duro State Park. The landscape consists of jagged caliche escarpments, colorful sandstone ledges and bluffs, steep talus slopes, and highly dissected red-bed plains. Within a horizontal distance of 100 to 400 feet, differences

in elevation are as much as 700 feet. The nearly barren caliche escarpments and sandstone cliffs are prominent but not extensive. Most of the escarpments are vertical.

Rough broken land makes up about 60 percent of the acreage; Mobeetie soils, 20 percent; and badlands and other unclassified, shallow soils and alluvial land, 20 percent. The proportion of each of these may vary 40 percent or more. Also in the mapping unit are small spots of Berda soils. About half the acreage of Rough broken land borders the High Plains. The rest is on the multicolored red beds and much dissected erosional red-bed soils in the Palo Duro Canyon.

In some areas geologic erosion removes material as fast as it forms. The badlands have been cut by deep, V-shaped gullies, and little or no vegetation grows on these areas. Badlands also make some adjacent areas suitable for range inaccessible to cattle.

Rough broken land furnishes limited grazing for livestock. The vegetation consists mainly of a thin cover of little bluestem, sideoats grama, and hairy grama, but some black grama and redberry juniper shrubs grow on the red-bed slopes below the escarpments. Yucca, catclaw, and dwarfed mesquite are scattered throughout the areas. Where accessible, the scenic areas are better suited to recreation, and the more rugged areas, to habitat for wildlife. (Dryland capability unit VIIs–2; Rough Breaks range site)

Spur Series

The Spur series consists of deep, calcareous, well-drained soils on smooth bottom lands. Because the adjacent meandering streams are deep and wide, these soils are flooded only during flash floods. The largest areas in the county are along Palo Duro and Tierra Blanca Creeks. Spur soils developed under mid and short grasses in calcareous sediment that washed from the watershed of Palo Duro Creek and its tributaries.

In a typical profile, the surface layer is friable, dark grayish-brown clay loam that is somewhat stratified and about 18 inches thick. The subsoil, also clay loam, is grayish brown and about 27 inches thick. The underlying material is dark grayish-brown silty clay loam that extends to a depth of more than 60 inches.

Spur soils are used for alfalfa, small grains, forage sorghum, and sudangrass in cultivated areas.

Typical profile of Spur clay loam (600 feet east and 50 feet south of bridge on west side of section 19, block 1, T.T. RR. Survey; or about 2 miles west and 5 miles north of Umbarger) in a pasture of native grass:

A1—0 to 18 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; stratified with organic matter and strains in upper part; granular and coarse prismatic structure in lower part; hard when dry, friable when moist; many, fine, fibrous roots; about 25 percent, by volume, is worm casts; irregular distribution of organic matter by micro- and macro-organisms is common throughout the horizon; fine and medium channels and pores common; calcareous; moderately alkaline; gradual boundary.

B2—18 to 45 inches, grayish-brown (10YR 5/2) clay loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure breaking to moderate, fine, subangular blocky and granular structure; worm casts are many in upper part but are less common in lower part; fine to medium old root channels common; calcareous; moderately alkaline; clear boundary.

C—45 to 60 inches +, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak subangular blocky structure; very hard when dry, firm when moist, sticky when wet; few roots; white coats of calcium carbonate line or fill many, fine, old root channels; calcareous; moderately alkaline.

Above the A horizon is 2 inches of brown silt loam that was deposited by water and wind. The A horizon ranges from clay loam to loam in texture and from 8 to 20 inches in thickness. When dry, this horizon ranges from dark brown to very dark grayish brown in hue of 10YR, value of 3 or 4, and chroma of 2 or 3. Because the content of stratified organic matter is high, this horizon is the darkest one in the profile.

The B2 horizon ranges from 10 to 40 inches in thickness. When dry, this horizon ranges from dark grayish brown to brown and has hue of 10YR or 7.5YR and value of 4 to 6. Texture ranges from silty clay loam to sandy clay loam. Structure is moderate, medium, granular to moderate, medium, subangular blocky. The B2 horizon contains less stratified organic matter and more lime than the A horizon.

In many places the lower part of the solum is somewhat stratified clay loam, silty clay loam, and sandy clay loam. One or more buried horizons of an old soil are common and occur at a depth of 25 to 50 inches.

At a depth of more than 5 or 6 feet, the C horizon is normally coarser textured and more stratified than the horizons above. Lenses of waterworn quartz and caliche gravel are few in the upper part of the C horizon, but are common at a depth of 8 to 10 feet. Color ranges from gray to brown to pale brown and dark grayish brown.

Spur soils are less sloping and more stratified than the adjoining Berda soils and contain slightly more clay.

Spur clay loam, broken (Sb).—This soil occurs on the low flood plains of the Palo Duro drainage system upstream from Lake Stockton Dam. Slopes range from 0 to 30 percent. Typically this soil includes old scar channels, sloping streambanks, and areas so small or cut by active meandering streams that cultivation is not practical. It is adjacent to smoother higher lying Spur clay loam, which is not subject to damaging flooding.

The surface layer is a calcareous, dark grayish-brown clay loam 10 to 20 inches thick. This layer contains moderate amounts of organic matter. In recent scar channels, all of the surface layer and some of the subsoil have been washed away. The subsoil is slightly lighter colored than the surface layer and consists of stratified loamy material 10 to 40 inches thick.

Included in mapping were areas of sandier nonarable soils that make up 25 percent of areas mapped.

Under good management, native grass grows better on this soil than on drier, deep soils of the upland having a similar texture. This is because moisture is added by floodwater. (Dryland capability unit Vw–1; Loamy Bottomland range site)

Spur clay loam (Sc).—This well-drained soil occurs in bottom lands of Palo Duro Creek and its tributaries. It formed in sediments washed from the High Plains. It is smoother and higher lying than adjacent Spur clay loam, broken, which is more cut and damaged by flooding. Slopes are 1 percent or less.

The surface layer is calcareous, dark grayish-brown, friable clay loam and is about 18 inches thick. This layer has moderate amounts of organic matter. The subsoil is calcareous, grayish-brown to brown, moderately permeable sandy clay loam to clay loam about 30 inches thick. In most places the subsoil is underlain by layers of a buried soil and stratified alluvium. These layers vary from silty clay

loam to sandy clay loam and have a combined thickness of several feet.

Included in mapping were a few areas of Berda loam and other soils that are sandier than the Spur clay loam. These soils and alkali spots, narrow streambanks, and stream bottoms make up as much as 20 percent of this mapping unit. Also included are areas of a Spur soil that has a sandy clay loam surface layer.

Spur clay loam has high to moderately high fertility and available water capacity. Its surface layer is mellow, takes water well, and is easy to till. A few areas have a fluctuating water table at a depth of 5 to 10 feet. About one-half of this soil is cultivated, and the rest is native grass range. Alfalfa is well adapted to subirrigated areas, but in other areas during dry periods, yields of sorghums and corn are commonly reduced by chlorosis.

Alfalfa, small grains, forage sorghum, and sudangrass grow well if moisture is favorable and management is good. Also, native grasses are nutritious and grow well if they are properly grazed. (Dryland capability unit IIe–1; irrigated, I–2; Loamy Bottomland range site)

Ulysses Series

The Ulysses series consists of calcareous, grayish-brown, loamy soils that occur on uplands and are nearly level and gently sloping. These soils are moderately deep over caliche. They formed under native grasses in loess on the High Plains. Ulysses soils occur in curved areas within broad, extensive areas of Pullman soils. They are also in bands of variable width on the rims of playas and the rims of most draws in the Palo Duro drainage system. Where they occur with Pullman soils, Ulysses soils are nearly level; on the rims of playas and draws, they are gently sloping.

In a typical profile, the surface layer is grayish-brown, very friable clay loam about 8 inches thick. The subsoil is also clay loam, but it is brown, friable, and about 22 inches thick. It is underlain by light-brown silty clay loam that extends to a depth of about 48 inches. In this layer, calcium carbonate concretions make up 20 percent of the soil mass. The next layer is yellowish-red clay loam. Earthworms and some rodents and insects are active in the solum.

Ulysses soils are used for winter wheat, grain sorghum, and native grass range.

Typical profile of a Ulysses clay loam (on the north slope of a large playa, about 1.5 miles south and 0.1 mile west of the northeast corner of Randall County) in a pasture of native grass:

A1—0 to 8 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; largely consists of worm casts below a depth of 2 inches; slightly hard when dry, very friable when moist; somewhat porous; many, fine, fibrous roots; calcareous; moderately alkaline; gradual boundary.

B2—8 to 30 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) when moist; compound moderate, medium, subangular blocky and granular structure; material is largely worm casts; hard when dry, friable when moist, slightly sticky when wet; somewhat porous; few scattered, fine- and medium-sized, nodular concretions of calcium carbonate that increase with depth; calcareous; moderately alkaline; clear boundary.

C1ca—30 to 48 inches, light-brown (7.5YR 6/3) silty clay loam, brown (7.5YR 5/3) when moist; compound weak, subangular blocky and granular structure; few fine roots; about 20 percent, by volume, is visible, weakly to strongly cemented concretions of calcium carbonate; 80 percent is porous soil material containing many, fine, old root channels and pores; calcareous; moderately alkaline; lower boundary.

C2—48 to 84 inches +, yellowish-red (5YR 4/6) heavy clay loam, light yellowish red (5YR 4/6) when moist; structureless; very hard when dry, friable when moist, sticky when wet; few finely segregated masses or pockets of calcium carbonate make up about 10 percent of the horizon; 90 percent is a somewhat porous soil material containing some threads and films of calcium carbonate; calcareous; moderately alkaline.

The A horizon ranges from clay loam to sandy clay loam in texture and from 7 to 13 inches in thickness. Color generally ranges from grayish brown to dark grayish brown in hue of 10YR. Value is 4 or 5 when this horizon is dry and is 3 when the horizon is moist. Chroma is 2 or 3. Hue is 7.5YR where Ulysses soils occur closely with Amarillo and Olton soils.

The B2 horizon ranges from light clay loam to silty clay loam in texture and from moderate to strong and granular to subangular blocky in structure. Color is grayish brown to light brownish gray in hue of 10YR to 7.5YR. Value is 5 or 6 when this horizon is dry and is 3 to 5 when the horizon is moist. The chroma is 2 to 4.

The C1ca horizon ranges from pale brown or light brown to pinkish white in hue of 10YR to 7.5YR. Value is 6 or 7 when this horizon is dry and is 5 or 6 when the horizon is moist. The content of visible calcium carbonate ranges from 10 to 30 percent. The C2 horizon is light brown or reddish yellow to yellowish red in hue of 7.5YR or 5YR. The texture is clay loam or heavy clay loam.

Ulysses soils occur with the Zita, Mansker, and Amarillo soils. They are not so dark colored as the Zita soils, are deeper than the Mansker soils, and are less sandy and less red than the Amarillo soils.

Ulysses clay loam, 0 to 1 percent slopes (UcA).—This soil occurs on smooth areas of the High Plains. A few small areas are on playa benches adjacent to the Zita soils. Other areas, which normally are curved, are within larger areas of Pullman soils on the broad flats. Areas generally range from 40 to 250 acres in size but dominantly are about 80 acres.

Soil blowing has removed 1 or 2 inches of the surface layer in most areas that have been farmed since the early 1930's. The present surface layer is dark grayish-brown, very friable clay loam 8 to 13 inches thick. The subsoil is grayish-brown to brown, friable clay loam that is moderately permeable and about 10 to 20 inches thick. The subsoil has strong granular structure. It is made up mostly of worm casts, and there are a few concretions of lime. The subsoil is underlain by light-brown to pinkish-white silty clay loam about 15 inches thick. This layer has accumulated lime in the upper part (fig. 15). The lower part contains less lime and is light reddish-brown clay loam.

Included in mapping were spots of Zita and Mansker clay loams and areas transitional to Pullman clay loam, moderately shallow. These inclusions make up as much as 15 percent of some mapped areas. The Pullman and Zita soils require about the same management as does this Ulysses soil, but Mansker soil may require special treatment to prevent the soil blowing encouraged by excessive lime.

This soil is very friable and easily tilled. It takes in water readily and releases to plants an amount favorable for their growth. Natural fertility and available water capacity are moderate. During the drier seasons, however, lime induces chlorosis that reduces growth of sorghums. Unpro-

Figure 15.—**Profile of Ulysses clay loam, 0 to 1 percent slopes. The light-colored material is a zone of accumulated lime.**

tected cultivated areas of this soil are susceptible to soil blowing.

Most of this soil is cultivated to winter wheat and sorghums, and the rest is in native grass. When moisture is favorable, good crop growth is obtained under improved practices of dryland farming. Alfalfa, a lime-tolerant crop, is particularly well suited under irrigation. (Dryland capability unit IIIce–3; irrigated, IIe–3; Hardland Slopes range site)

Ulysses clay loam, 1 to 3 percent slopes (UcB).—This gently sloping soil is moderately deep over caliche. It occurs on a part of the rims of the larger playas and the draws of the Palo Duro drainage system. Most areas range from 30 to 200 acres in size, but they are dominantly about 70 acres. The areas are irregular and oblong in shape and they follow the contour of the landscape. They are between Mansker or Potter soils, which are downslope, and Pullman clay loam or Olton clay loam, which are upslope. Some areas are within larger areas of sloping Pullman soils.

Except that the surface layer and subsoil is slightly thinner, and there is not so much lime in the accumulated zone, the profile of this soil is similar to the one described as typical for the Ulysses series.

Included with this soil in mapping were small, scattered areas of Zita, Mansker, and Potter soils. Also included, in areas as much as 5 acres in size, are a few severely eroded spots of Ulysses and Mansker soils. The included areas make up about 15 percent of the area mapped.

This Ulysses soil is very friable and easy to till. Natural fertility and available moisture capacity are moderate. But the lime in this soil commonly causes chlorosis in grain sorghum and reduces crop growth. Soil blowing is likely in areas that are cultivated but not protected. If crop residues are not managed properly and runoff is not controlled, rills and gullies form in sloping areas.

About one-third of the soil is cultivated. Most of the cultivated acreage is dryfarmed, but a few areas are irrigated. The remaining acreage is native range. Winter wheat and grain sorghums are well suited. Alfalfa is well suited to irrigated areas. (Dryland capability unit IIIe–3; irrigated, IIIe–4; Hardland Slopes range site)

Woodward Series

The Woodward series consists of well-drained, red soils on uplands. These soils are moderately deep over caliche. They developed on red beds consisting of calcareous, weekly consolidated siltstone and very fine-grained sandstone of Permian age. The native vegetation was mid grasses. Woodward soils occupy the smoother areas of erosional red-bed plains in the Palo Duro Canyon.

In a typical profile, the surface layer is calcareous, red very fine sandy loam about 10 inches thick. The subsoil is also very fine sandy loam about 10 inches thick. It is underlain by red, very fine sandy loam that extends to a depth of 36 inches and is underlain by weakly consolidated sandstone and siltstone.

In this county the Woodward soils were mapped only in a complex with Quinlan soils.

Typical profile of a Woodward soil that has a very fine sandy loam surface layer (in Palo Duro State Park, 400 feet south and 75 feet west of the entrance to the amphitheater):

A1—0 to 10 inches, red (2.5YR 4/5) very fine sandy loam, dark red (2.5YR 3/5) when moist; weak subangular blocky and granular structure; slightly hard when dry, very friable when moist; worm casts and nests common; calcareous; moderately alkaline; gradual boundary.

B2—10 to 20 inches, reddish-brown (2.5YR 5/4) very fine sandy loam, reddish brown (2.5YR 4/4) when moist; moderate, medium and coarse, subangular blocky and granular structure; slightly hard when dry, very friable when moist; worm casts many in upper part and common in lower part; fine and medium pores and channels common; calcareous; moderately alkaline; gradual boundary.

C1ca—20 to 36 inches, red (2.5YR 5/6) very fine sandy loam, red (2.5YR 4/6) when moist; moderate, medium, subangular blocky structure; hard when dry, very friable when moist; porous; a few very fine (0.5 to 1 millimeter in diameter) segregated concretions of calcium carbonate; calcareous; moderately alkaline.

C2—36 to 45 inches +, dark-red (2.5YR 3/6), weakly consolidated, coarse, platy, fine-grained sandstone and and siltstone containing thin lenses of silty to clayey shale; calcareous; moderately alkaline.

The A horizon ranges from reddish brown to red in hue of 5YR or 2.5YR. Color value ranges from 4 to 5.5 when this horizon is dry and from 3 to 5 when it is wet. Chroma ranges from 3 to 6. Texture ranges from very fine sandy loam to fine sandy loam or loam, and thickness ranges from 6 to 15 inches.

The B2 horizon ranges from reddish brown to dark reddish brown in hue of 2.5YR or 5YR and has chroma of 4 or 5. This horizon ranges from 4 to 15 inches in thickness.

The C1ca horizon is generally weakly developed and in places is barely visible.

Woodward soils are smoother, deeper, and less eroded than the closely intermingled Quinlan soils and have more distinct horizons.

Zita Series

Zita series consists of nearly level to gently sloping, dark, well-drained, loamy soils on uplands. These soils are moderately deep over caliche. They developed on the High Plains in limy loess of late Pleistocene origin. The native vegetation was short and mid grasses. These soils occupy slightly concave areas on the higher benches of the large playas and along drainageways. They are also in small, scattered areas throughout the county.

In a typical profile, the surface layer of these soils is dark grayish-brown, very friable clay loam about 10 inches thick. The subsoil is also clay loam, but it is brown, friable, and about 12 inches thick. The next layer extends to a depth of more than 66 inches and consists mostly of pink and light-brown clay loam that is chalky in the upper part.

Surface drainage is medium, and permeability is moderate. Zita soils are normally free of lime to a depth of 15 inches. Cultivated crops and range are the main uses.

Typical profile of a Zita clay loam (in an irrigated field 2,950 feet south and 100 feet west of the northeast corner of section 36, block 1, T.T. Railroad Company Survey; or about 5 miles north and 1 mile west of Canyon):

Ap—0 to 10 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak granular structure; hard when dry, very friable when moist, slightly sticky and plastic when wet; neutral; gradual boundary.

B2—10 to 22 inches, brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, subangular blocky and granular structure; hard when dry, friable when moist, sticky and plastic when wet; many worm casts and nests; few, thin, patchy clay films on the larger peds; many fine- and some medium-sized pores and channels; mildly alkaline in upper part and moderately alkaline in lower part; calcareous in lower part; abrupt boundary.

C1ca—22 to 38 inches, pink (7.5YR 7/4) chalky clay loam, light brown (7.5YR 6/4) when moist; structureless; fine old root channels common; about 50 percent, by volume, is mostly dispersed chalky and some moderate-sized lumps and many, fine, weakly cemented concretions of calcium carbonate; moderately alkaline; calcareous; gradual boundary.

C2—38 to 66 inches +, light-brown (7.5YR 6/4) clay loam, reddish yellow (7.5YR 6/6) when moist; massive; some scattered, weakly cemented, fine lumps of concretions of calcium carbonate that are smaller and less numerous than in the Cca horizon above.

The A horizon ranges from 9 to 17 inches in thickness and from clay loam to loam or silty clay loam in texture. Color is strongly influenced by the content of organic matter and ranges from dark brown to very dark grayish brown in hue of 10YR and chroma of 2 or 3. Value is 3 or 4 when this horizon is dry and 2 or 3 when the horizon is wet. Structure is mostly moderate, medium, granular in areas of clay loam under native grass. In cultivated areas of loam or clay loam, the material is almost structureless.

The B2 horizon ranges from 12 to 20 inches in thickness and from brown to grayish brown in color. Hue is mostly 10YR but is 7.5YR in some places. When it is dry, the B2 horizon has value of 5, but value is 4 when this horizon is moist. Chroma is 2 or 3.

The C1ca horizon is generally prominent. It is at a depth ranging from 20 to 40 inches and is 10 to 30 inches thick. Color ranges from white or pink to grayish brown in hue of 10YR or 5YR. Value is 6 or 7 when the C1ca horizon is dry and is 5 or 6 when this horizon is wet. Chroma ranges from 2 to 4. Texture ranges from clay loam to fine sandy loam. About 15 to 60 percent or more of the soil mass, by volume, is weakly cemented to strongly cemented concretions of calcium carbonate. Where the Zita soils occur in playas, the C2 horizon is generally missing. In other areas it is reddish yellow and has hue of 5YR or 10YR. When this horizon is dry or moist, value is 6. Chroma ranges from 4 to 6.

Zita soils are darker and less clayey than the associated Pullman soils and are shallower over caliche. They are similar to the Lofton soils in color but are less clayey and shallower over caliche. Zita soils are darker than Ulysses soils and are leached of lime to a depth of about 15 inches.

Zita clay loam, 0 to 1 percent slopes (ZcA.)—This soil is widely distributed throughout the county. It occurs in small, slightly concave areas on the tableland of the High Plains and on the higher benches of the larger playas.

The surface layer is neutral, dark-brown to dark grayish-brown, very friable clay loam about 15 inches thick (fig. 16). The subsoil is brown, moderately permeable, calcareous clay loam about 18 inches thick. Much of the surface layer and subsoil is made up of worm casts, and a large amount of organic matter has been uniformly distributed by plants and soil organisms. The upper part of the substratum is a prominent, pink to pinkish-white layer of accumulated lime about 18 inches thick. The rest of the substratum is light-brown, reddish-brown to reddish-yellow, massive material containing less lime than the layer above.

Included with this soil in mapping were areas of Ulysses and Pullman soils on the upland flats. Also included, generally in areas less than 5 acres in size, are spots and narrow bands that are transitional to the Ulysses and Pullman soils. The included areas make up less than 6 percent of the areas mapped. Pullman soils can be managed the same way as this Zita soil, but the Ulysses soils may require special treatment because they are susceptible to blowing.

This friable Zita soil is well drained and easy to till. It takes in water well and has high available water capacity and natural fertility. Because the surface layer is granular, however, it is slightly susceptible to soil blowing in unprotected tilled areas.

This soil is among the most desirable in the county for farming. It is particularly well suited to irrigation. Most of this soil is cultivated, mainly to winter wheat and grain sorghum. The remaining acreage is in native range in which grasses are short. (Dryland capability unit IIIce-2; irrigated, I-2; Deep Hardland range site)

Zita clay loam, 1 to 3 percent slopes (ZcB).—This soil occurs on some of the playa benches and in draws of the county. Most areas range from 20 to 50 acres in size. This soil normally is in narrow bands and has slopes dominantly of about 2 percent. The surface is plane or weakly concave.

This soil has a neutral, dark-brown, very friable clay loam surface layer about 10 inches thick. The subsoil is brown, moderately permeable, calcareous clay loam about 15 inches thick.

Figure 16.—**Profile of Zita clay loam, 0 to 1 percent slopes. The light-colored layer is the zone of accumulated lime.**

Included in mapping were narrow areas that are transitional to Ulysses and Pullman soils. These included areas make up as much as 10 percent of the areas mapped. Ulysses soils may require special treatment because cultivated areas are susceptible to blowing if left unprotected.

This well-drained, nondroughty soil absorbs water well and has moderately high available water capacity and natural fertility. It is moderately susceptible to soil blowing and water erosion in cultivated areas. In dryfarmed areas crop growth is good to excellent when moisture is favorable. Winter wheat and grain sorghum consistently grow well in well-managed irrigated areas. (Dryland capability unit IIIe-2; irrigated, IIe-1; Deep Hardland range site)

Use and Management of Soils

The soils in Randall County are used mostly for crops, but a large acreage is used for grazing livestock. This section tells how the soils are used for these main purposes and also for windbreaks, wildlife, and engineering structures. In addition, the system of classification used by the Soil Conservation Service is explained, and management of the capability groups of soils in the county is discussed. A table gives predicted yields of principal crops grown on the soils under dryland and irrigated farming.

Capability Groups of Soils [2]

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The classification does not apply to most horticultural crops, or to rice and other crops that have their own special requirements. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without considerations of possible but unlikely major reclamation projects.

In the capability system, all soils are grouped at three levels, the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groupings, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. Classes are defined as follows:

Class I. Soils have few limitations that restrict their use.

Class II. Soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III. Soils have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Class IV. Soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V. Soils subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in the county.)

[2] By ALLEN H. KING, field specialist in agronomy, Soil Conservation Service.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability units

In the following pages the irrigated and the dryland capability units in Randall County are described, and suggestions for the use and management are briefly given. All the soils in the county have been placed in dryland capability units, but only those soils suited to irrigation have been placed in irrigated capability units. The mention of soil series in the description of a capability unit does not mean that all the soils in the series are in the unit. The names of the soils in any capability unit can be found in the "Guide to Mapping Units" at the back of the survey.

In applying water to the soils in the irrigated capability units either a surface or a sprinkler irrigation system is used, depending mainly on slope and permeability of the soils. A properly designed surface system that provides ditches and pipelines is more efficient on soils that have a subsoil of slowly permeable clay or clay loam. More efficient on the more permeable soils is a sprinkler system that has perforated pipelines or fixed or portable high-pressure pipes and nozzles. In both kinds of systems irrigation water can be applied without waste and without loss of soil through erosion.

IRRIGATED CAPABILITY UNIT I-1

Olton clay loam, 0 to 1 percent slopes, is the only soil in this capability unit. This deep, nearly level soil has a dark, friable surface layer. The subsoil is moderately slowly permeable clay loam to heavy clay loam. Soil fertility and available water capacity are high. The hazard of soil blowing is slight.

Grain sorghum, forage sorghum, and wheat are the main crops on this soil but alfalfa, cotton, and other crops are also suited. In a suitable cropping system sorghums and wheat are grown in rotation, fertilizer is added, and crop residue is well managed so that erosion is controlled and moisture is conserved. Nitrogen is the most needed plant nutrient.

IRRIGATED CAPABILITY UNIT I-2

This capability unit consists of deep to moderately deep, nearly level soils of the Acuff, Spur, and Zita series. These soils have a dark, friable loam to clay loam surface layer. The subsoil is clay loam to heavy clay loam that is moderate to moderately slow in permeability. Fertility and available water capacity are high. The soils in this unit are easily tilled and are only slightly susceptible to soil blowing.

Grain and forage sorghums are the main crops, but wheat, oats, and alfalfa are also grown. A cropping system that provides sorghums and small grains grown in rotation with a legume is suitable if fertilizer is added and crop residue well managed. Such a system helps in controlling erosion and in conserving moisture. Nitrogen is the most needed plant nutrient. Growth of alfalfa is increased by adding a phosphate fertilizer in adequate amounts.

DRYLAND CAPABILITY UNIT IIe-1

Spur clay loam is the only soil in this capability unit. This deep, well-drained soil is inextensive in the county and occurs on bottom lands of Palo Duro Creek and its tributaries. The surface layer is clay loam, and the subsoil is moderately permeable clay loam. Available water capacity and natural fertility are high to moderately high. Crops grow well if the moisture content is favorable and management is good.

Wheat, small grains, and forage sorghum are grown in most cropping sequences used. Residues from these crops should be kept on the the surface through critical periods of soil blowing. Effective use of crop residues also helps to control water erosion and conserve moisture. If the crop residues are plowed under, they add to the organic-matter content and help to maintain fertility. Occasionally, emergency tillage is needed for roughening the soil surface and reducing soil blowing when residues are not sufficient to provide adequate protective cover.

IRRIGATED CAPABILITY UNIT IIe-1

This capability unit consists of deep, gently sloping, well-drained, loamy soils of the Acuff and Zita series. These soils have a fairly thick, dark, friable surface layer. The subsoil has moderate to moderately slow permeability. Soil fertility and available water capacity are high. These soils are moderately susceptible to water erosion and slightly to moderately susceptible to soil blowing.

Wheat and grain sorghum are the main crops. Large amounts of residues from these crops should be left on the soil for protection against erosion and then plowed under to improve tilth. Crop residues left on the surface are also beneficial for controlling water erosion if used with land leveling or similar measures. Additions of fertilizer are needed for maintaining fertility. The soils in this unit require large additions of a nitrogen fertilizer. Occasional additions of phosphate fertilizer are beneficial to the Zita soil. Irrigation water can be efficiently applied in a properly designed surface or sprinkler system.

IRRIGATED CAPABILITY UNIT IIe–2

Olton clay loam, 1 to 3 percent slopes, is the only soil in this unit. This soil has a noncalcareous clay loam surface layer and a subsoil with moderately slow permeability. Available water capacity and soil fertility are high. This soil is susceptible to both soil blowing and water erosion.

Wheat and sorghums are the main crops. Residues from these crops should be left on or near the surface for protection during critical periods of soil blowing and water erosion. Tilth is improved if the residues are plowed under. Crops respond to large additions of nitrogen fertilizer.

IRRIGATED CAPABILITY UNIT IIe–3

Ulysses clay loam, 0 to 1 percent slopes, is the only soil in this capability unit. This nearly level soil has a moderately permeable subsoil and is moderately deep over caliche. Available water capacity and natural fertility are moderate. The lime in this soil makes the surface layer moderately susceptible to soil blowing.

Wheat and sorghums are the main crops. Residues from these and other crops normally are sufficient for protection against erosion, but the residues must be managed carefully so as to protect the soils against soil blowing during critical periods in winter and spring. Additions of nitrogen fertilizer are required to maintain growth of crops.

IRRIGATED CAPABILITY UNIT IIs–1

This capability unit consists of deep to moderately shallow, nearly level soils. These soils are in the Lofton, Pullman, and Roscoe series. They have a noncalcareous clay loam or clay surface layer that is underlain by clay. Pullman soils are nearly level in most places, and the Lofton and Roscoe soils are on the benches of many playas and depressions.

The soils in this unit are moderately high in fertility and available water capacity. Most of them crack deeply into the subsoil when they are dry. During rains, water enters the cracks rapidly and wets the soils. Then the clay swells, the cracks seal, and movement of water is slowed.

Wheat and grain sorghum are the main crops. Field corn is grown in some areas (fig. 17). The large amounts of residues left by all of these crops should be returned to the soil. Additions of nitrogen fertilizer increase crop growth and the amount of crop residues. Also, crops benefit from additions of a phosphate fertilizer. Crop residues managed well and kept at or near the surface help in controlling soil blowing and water erosion.

Figure 17.—**Harvesting irrigated field corn on Pullman clay loam. Silage from the corn is used as dairy feed.**

DRYLAND CAPABILITY UNIT IIIe–1

This capability unit consists of deep and moderately shallow, gently sloping soils. These soils are in the Pullman series. They have a noncalcareous clay loam surface layer and a slowly permeable clay subsoil. Natural fertility and available water capacity are high. The hazard of water erosion is moderate, and that of soil blowing is slight.

Wheat and grain sorghum are the main crops and are grown in rotation. If the residues from these crops are left on the surface, they help in controlling water erosion and soil blowing. This practice also allows more rainfall to enter the soil and helps to conserve moisture. Lack of moisture is the main concern of management. Since there may not be enough crop residues to protect the soil in dry years, emergency tillage should be used to roughen the surface so as to help control soil blowing. Terraces are needed on these soils, and if contour farming is also used, furrows and ridges give additional protection.

IRRIGATED CAPABILITY UNIT IIIe–1

In this capability unit are deep or moderately shallow, gently sloping soils that have a clay loam surface layer and a slowly permeable clay subsoil. These soils are in the Pullman series. They occupy the slopes of draws and rims of the larger playas in the county. Available water capacity and natural fertility are high. Soil blowing is only a slight hazard, but water erosion is a moderate hazard in the more sloping areas.

Wheat and grain sorghum are the main crops. Cotton is grown in a small acreage in the southern part of the county. Alfalfa is occasionally grown in small areas where enough irrigation water is available.

Returning large quantities of crop residues to the soil is essential. Enough crop residues should be left on and near the surface to help in controlling erosion and in maintaining good growth of crops. Fertility can be maintained by applying fertilizer.

DRYLAND CAPABILITY UNIT IIIe–2

This capability unit consists of deep to moderately deep, gently sloping soils that have a friable loam to clay loam surface layer. The subsoil is clay loam or heavy clay loam to sandy clay loam that is moderately permeable to moderately slowly permeable. These soils are in the Acuff, Olton, and Zita series. Natural fertility and available water capacity are high to moderately high. Susceptibility to both water erosion and soil blowing is moderate.

These soils are used for small grains, grain sorghum, and native grass. Residues from the tilled crops are used to protect the soil surface by leaving them on the surface during critical periods of soil blowing and water erosion. The residues improve the soils when they are plowed under. Terraces are needed for controlling water erosion. They are most effective in controlling erosion and in conserving moisture when residues are properly managed.

IRRIGATED CAPABILITY UNIT IIIe-2

This capability unit consists of deep to moderately deep, gently sloping to moderately sloping soils on uplands. These soils have a clay loam to loam surface layer and a clay loam to clay subsoil that is moderately slow in permeability. Fertility and available water capacity are high to moderately high. These soils are in the Berda, Olton, and Pullman series.

Small grains and sorghums are generally grown on these soils. Crop growth is impaired on the Pullman and Olton soils by the effects of erosion. Wheat, grain sorghum, or similar crops that provide a protective cover help to prevent further damage. Crop residues from these crops are needed on the surface through critical periods of erosion and periods of fallow. Additions of fertilizer are required to maintain growth of crops.

DRYLAND CAPABILITY UNIT IIIe-3

This capability unit consists of moderately deep, gently sloping, loamy soils that are in the Berda and Ulysses series. These soils formed in local alluvium on foot slopes and in a loessal mantle on the High Plains. They occur on the side slopes of draws and rims of the larger playas in the county. Their surface layer is friable clay loam. The subsoil is moderately permeable and contains slightly more clay than the surface layer. Available water capacity and soil fertility are moderate. Also moderate is the hazard of soil blowing and water erosion.

Wheat and grain sorghum are the main crops. In some fields enough lime is in the soils to cause chlorosis in young sorghum plants. Spraying the leaves with iron sulfate is often effective in treating chlorosis. When plants are not growing on these soils, residues from wheat and sorghum are needed for protection. Normally, stubble mulching or stubble tillage provides enough protection through critical periods of soil blowing and water erosion. Emergency tillage is used to roughen the surface and prevent further damage from soil blowing when there are not enough crop residues. Contour farming, along with terraces, is helpful in controlling water erosion.

IRRIGATED CAPABILITY UNIT IIIe-4

This capability unit consists of moderately deep, gently sloping, loamy soils that have a moderately permeable subsoil. These soils are in the Berda and Ulysses series. They are the same soils as those in capability unit IIIe-3, dryland, but only a small part of the acreage is irrigated.

Wheat and sorghums are normally grown on these soils. Applying fertilizer and returning crop residues to the soils help maintain fertility and good tilth.

DRYLAND CAPABILITY UNIT IIIe-4

In this capability unit are level to gently sloping, well-drained soils that occur on the High Plains. These soils are in the Amarillo series. They have a fine sandy loam surface layer and a moderately permeable sandy clay loam subsoil. Content of organic matter is fair, and soil fertility is high to moderately high. Available water capacity is moderately high. The hazard of soil blowing is moderate, and that of water erosion is slight to moderate.

Wheat and grain and forage sorghums are the main crops. Residues from these crops left on the surface help in controlling water erosion and soil blowing. Emergency tillage is necessary for roughening the surface when crop residues are not sufficient for controlling blowing. Contour farming is essential for controlling water erosion on the sloping soils of many fields. Terraces are needed for reducing water erosion on the more sloping soils.

IRRIGATED CAPABILITY UNIT IIIe-10

This unit consists of nearly level to gently sloping, calcareous Mansker soils that occur in small, scattered areas throughout the county. These soils have a clay loam surface layer and a moderately permeable, limy clay loam subsoil. Soil fertility and available water capacity are moderately low. These soils are easily tilled, but they are very susceptible to soil blowing if not protected by a plant cover. Water erosion is also likely on unprotected slopes.

Irrigated wheat and sorghums are commonly grown on the soils of this unit. The sorghums are commonly damaged by chlorosis. This disease reduces crop growth even though the leaves of the sorghum plants are sprayed with iron sulfate. Where ample irrigation water is available, alfalfa is particularly well suited. Stubble mulching helps to conserve moisture, build up the content of organic matter, and reduce soil losses through erosion.

DRYLAND CAPABILITY UNIT IIIce-1

This unit consists of deep to moderately shallow, nearly level, slowly permeable soils. These soils are in the Pullman, Roscoe, and Lofton series. They have a clay loam surface layer and a slowly permeable clay subsoil. Soil fertility and available water capacity are high. The hazards of soil blowing and water erosion are slight.

Grain sorghum and wheat are the main crops. Forage sorghum and small grains other than wheat are sometimes grown in the cropping systems. Lack of moisture is normally the main concern of management. Stubble mulching and other practices that include use of crop residues, along with timely and minimum tillage, are most essential for maintaining good growth of crops. Such practices help to control erosion and to conserve moisture. Since there may not be enough residues to protect the soil, emergency tillage should be used to roughen the surface and to form protective clods. If crop residues are left on the surface, they help to trap and hold snow.

DRYLAND CAPABILITY UNIT IIIce-2

This unit consists of moderately deep to deep, nearly level Acuff, Olton, and Zita soils. These soils have a loam to clay loam surface layer and a loamy subsoil that is moderate to moderately slow in permeability. Soil fertility and available water capacity are high. Soil blowing is a moderate hazard. Since slopes are less than 1 percent, water erosion is only a slight hazard.

Wheat and grain sorghum are the main crops and are grown in a crop rotation. Residues from these crops left on the surface help in controlling soil blowing. This practice also allows more rainfall to enter the soil and reduces loss of moisture through evaporation. Lack of moisture is the main concern of management. In dry years when crop residues are not sufficient to protect the soil, emergency tillage should be used to roughen the surface. In some places where runoff causes water erosion, terraces and grassed waterways are needed.

DRYLAND CAPABLITY UNIT IIIce-3

Ulysses clay loam, 0 to 1 percent slopes, is the only soil in this capability unit. This calcareous soil is moderately deep over caliche. The surface layer is very friable clay loam, and the subsoil is moderately permeable limy clay loam. Soil fertility and available water capacity are moderate. The hazard of water erosion is slight, and the hazard of soil blowing is moderate.

Wheat and sorghums are the main crops. Lime sometimes induces varying degrees of chlorosis in sorghums, but in most years the plants recover and grow fairly well. Lack of moisture is generally the main concern of management. Crop residues are needed on this soil to help control soil blowing. These residues are generally sufficient for protection, but emergency tillage is also needed in exceptionally dry years.

IRRIGATED CAPABILITY UNIT IIIes-1

Only Drake soils, 1 to 3 percent slopes, are in this capability unit. These well-drained soils formed on smooth upland dunes on the leeward side of large playas on the High Plains. These soils have a predominantly clay loam surface layer that is rich in lime, but the texture ranges from clay to sandy loam. The subsoil is moderately permeable, limy clay loam. Natural fertility is unbalanced. Capacity to supply plant nutrients to plants is moderate. Available water capacity is moderate to low. The hazard of soil blowing is severe, and that of water erosion is moderate.

Alfalfa, wheat, and rye are the main crops, but growth of these and other crops is generally poor to fair. Chlorosis severely affects sorghums during their seedling stage, for the lime in these soils ties up essential plant nutrients, such as iron and phosphorus, and they are not available to the plants. Small grains, alfalfa, and other close-growing crops that produce much residue are needed to prevent soil drifting and washing. Range is a better use than field crops.

DRYLAND CAPABILITY UNIT IVes-1

Only Drake soils, 1 to 3 percent slopes, are in this capability unit. These deep, very limy soils formed on low ridges or dunes on the east side of some of the larger playas in Randall County. They have a limy mostly clay loam surface layer and a moderately permeable, limy clay loam subsoil. Texture of the surface layer ranges from clay to sandy loam. Available water capacity is moderate to low. Capacity to supply available plant nutrients is moderate. The hazard of soil blowing is high, but that of water erosion is moderate.

Cultivated crops normally are not grown on these soils, for crop growth is only poor to fair. Sorghums are commonly damaged by chlorosis because the large amount of lime makes iron, phosphorus, and other essential elements unavailable to plants. Sorghums, however, are sometimes grown in a rotation with small grains. If residues from tilled crops are left on the surface through most or all of the year, they help to control both soil blowing and water erosion. Also needed on long slopes are erosion control structures, such as terraces and waterways. Native grass is suited to this soil.

DRYLAND CAPABILITY UNIT IVe-1

Only Olton clay loam, 3 to 5 percent slopes, is in this capability unit. This deep, moderately sloping soil has a clay loam surface layer. The subsoil is a heavier clay loam and is moderately slow in permeability. Available water capacity and soil fertility are moderately high. The hazard of soil blowing is slight, but that of water erosion is moderately severe in the more sloping areas.

In the cropping system closely spaced sorghums, which leave much residue, are well suited. The residue should be kept on or near the surface so as to control soil blowing and water erosion. Terraces are also needed for protection against water erosion. In most years, crop growth is poor to fair. Range is a better use than field crops.

DRYLAND CAPABILITY UNIT IVe-2

In this capability unit are moderately sloping, calcareous loamy soils that are in the Berda and Mansker series. These soils have loam to clay loam surface layer and a moderately permeable loamy subsoil. Available water capacity is low to moderately low. Capacity to hold plant nutrients is moderate, but soil fertility is moderately low. The hazard of soil blowing is severe, and that of water erosion is moderately severe.

Well suited crops are closely spaced sorghums and small grains. If residues from these crops are carefully managed, they help to control water erosion and soil blowing. The chlorosis that affects sorghums in some years can be lessened by applying iron sulfate at proper stages of plant growth. Field crops do not grow so well as native grass.

DRYLAND CAPABILITY UNIT IVe-3

Pullman clay loam, 1 to 3 percent slopes, eroded, is the only soil in this capability unit. This soil occurs along upper slopes of draws and rims of larger playas. The clay loam surface layer commonly is only about 3 inches thick because nearly half of the original surface soil has been removed by water erosion. In some cultivated areas crusting, washing, and blowing have been encouraged by the mixing of the clayey subsoil with the original surface soil. This soil takes in water slowly. Available water capacity and soil fertility are moderate to moderately high.

Cropping systems that provide small grains, sorghums, or similar crops that leave much residues are suitable. The residues should remain on the surface soil during as much of the year as possible. Because soil blowing and water erosion are likely, this soil is better suited to grass than to cultivated crops. In most years crop growth is poor to fair. Terraces used with contour farming are needed for controlling erosion. Excess runoff can be removed by grassed waterways. Roughening the surface is occasionally required for controlling soil blowing.

DRYLAND CAPABILITY UNIT IVe-4

Amarillo fine sandy loam, 3 to 5 percent slopes, is the only soil in this capability unit. This soil has a sandy clay loam subsoil. Water enters this soil readily, and available water capacity and fertility are moderate. The hazard of water erosion is moderate, but that of soil blowing is moderately severe.

A cropping system that includes small grains and sorghums is needed. Residues from these crops should be kept on or near the surface so as to control erosion. Contour farming used in combination with terracing also is needed. Grassed waterways are effective in carrying runoff water from some fields. Roughening of the surface soil

helps to control soil blowing where there is not enough residue for protection.

DRYLAND CAPABILITY UNIT IVe–5

The only soil in this capability unit is Mobeetie fine sandy loam, 3 to 5 percent slopes. This soil is in a small area below escarpments and along the lower slopes of draws in the High Plains. It is moderately deep over caliche. The surface layer is grayish-brown fine sandy loam, and the subsoil is moderately rapidly permeable. Available water capacity is low to moderate. Capacity to hold plant nutrients and fertility are moderately low. Susceptibility to soil blowing and water erosion are moderate. Cultivated crops are not suited, and all the acreage is in native range.

IRRIGATED CAPABILITY UNIT IVe–6

Mansker clay loam, 3 to 5 percent slopes, is the only soil in this capability unit. This soil normally occurs in small areas on the stronger slopes of draws and parts of the playa rims. The surface layer is dark, calcareous clay loam, and the subsoil is moderately permeable clay loam. Available water capacity is low to moderately low. Capacity to hold plant nutrients is moderate, and soil fertility is moderately low. This soil is easy to till, but it is extremely susceptible to soil blowing and water erosion if not protected. Most of this soil is dryfarmed; only a small part is irrigated.

A suitable cropping system is one that includes small grains, sorghums, and alfalfa. The chlorosis that commonly affects sorghums can be lessened by spraying the leaves with iron sulfate. Stubble mulching is essential for conserving moisture, maintaining the content of organic matter, and reducing soil losses through erosion.

DRYLAND CAPABILITY UNIT IVe–9

This capability unit consists of nearly level to gently sloping soils of the Mansker series. These soils are along draws and parts of rims of larger playas. They have a surface layer of very friable, calcareous clay loam. The subsoil is calcareous, moderately permeable clay loam. Soil fertility and available water capacity are moderately low. The hazard of soil blowing is moderate. Water erosion may occur in the more sloping areas that are not protected by plant cover.

Small grains, grain sorghums, and similar crops are suitable, for they protect the soil while they are growing. Also, residue from these crops, if well managed, helps to control soil blowing and water erosion. Normally, terracing is required in more sloping areas.

DRYLAND CAPABILITY UNIT Vw–1

Spur clay loam, broken, and Broken alluvial land make up this capability unit. They occur along the bottoms of Palo Duro Creek, its tributaries, and Cita Creek. The Spur soil has a friable loamy surface layer and a moderately permeable subsoil of stratified light clay to loamy sand. This soil is occasionally flooded by overflowing streams and runoff water from higher soils. Broken alluvial land varies in texture, but its subsoil has moderately rapid permeability. This land is frequently flooded. In areas of the Spur soil and Broken alluvial land, old scar channels, streambanks, and channels cut by active meandering streams are prominent.

The soil and land type in this unit are not suitable for cultivation. Native grass, however, grows well because of the extra moisture added by flooding.

DRYLAND CAPABILITY UNIT VIw–1

Only Randall clay is in this capability unit. This deep soil formed on floors of playas in lacustrine sediment that was washed from surrounding, higher lying soils of the High Plains. The surface layer is very slowly permeable clay 18 to 30 inches thick. It is underlain by very slowly permeable clay several feet thick.

This soil is used mostly for range (fig. 18). It is also a good resting place for ducks, geese, and other migratory birds when it is flooded by runoff water.

DRYLAND CAPABILITY UNIT VIe–1

This unit consists of moderately sloping to sloping, limy soils on uplands, mainly above and near the escarpment of the High Plains and the stronger side slopes of draws. These soils have a loam or clay loam surface layer. They are in the Berda and Mansker series. In the Mansker soil a caliche layer is at an average depth of 15 inches. Where caliche occurs in the Berda soil, it is at a depth of about 20 or 30 inches. Available water capacity is low to moderately low. When the plant cover is in good condition, the rate of water intake is good.

The soils in this unit are used for range.

DRYLAND CAPABIITY UNIT VIe–2

Mobeetie fine sandy loam, 5 to 12 percent slopes, is the only soil in this capability unit. This soil occurs on foot slopes along the Palo Duro Canyon, other canyons, and draws in the county. The surface layer is calcareous fine sandy loam, and the subsoil is friable loam to sandy loam that has moderately rapid permeability. Water is absorbed rapidly, and available water capacity is low to moderate.

This soil is used as native range. The vegetation is chiefly tall and mid grasses, but other common plants are bluestems, sideoats grama, blue grama, and associated herbs and forbs.

DRYLAND CAPABILITY UNIT VIe–3

Only Drake soils, 3 to 8 percent slopes, are in this capability unit. These soils formed on eolian dunes on the leeward side of the larger playas in the county. The surface layer is very friable, limy fine sandy loam to clay loam. The subsoil is moderately permeable calcareous clay to sandy clay loam. These soils take in water fairly well. Available water capacity is fair, and soil fertility is unbalanced.

Soil blowing is the main hazard. Because the soils are rich in lime, they tend to become fluffy or powdery in exposed areas. A slight breeze can pick up the soil particles and move them easily. Water erosion is likely on strong slopes where there is a lack of good cover. Most of the acreage is range.

DRYLAND CAPABILITY UNIT VIe–4

Only Quinlan-Woodward complex is in this capability unit. The soils in the complex are in the Palo Duro Canyon on the smoother, erosional red beds above the narrow flood plains. The soils are sloping to steep. They have a very fine sandy loam surface layer. The subsoil is very fine sandy loam that is moderately to moderately slow in permeability.

Figure 18.—Cattle grazing in a shallow playa. The soil is Randall clay.

Available water capacity is low to moderate, and natural fertility is moderately low to moderate.

All of the acreage of this complex is in native range. The Woodward soil is deeper than the Quinlan soil and supports a thicker stand of grass.

DRYLAND CAPABILITY UNIT VIIs-1

In this unit are very shallow to moderately deep, calcareous, gently sloping to steep soils of the High Plains. These soils are in the Potter, Kimbrough, and Lea series. The Kimbrough soil is very shallow, sloping to moderately sloping, and loamy. It occurs on knolls and ridges and is underlain by hard, rocklike caliche at a depth of less than 10 inches. Lea soil is similar to the Kimbrough soil but has a smoother surface and less angular fragments of caliche. Also, the Lea soil has indurated caliche at a depth of about 22 inches. Potter soils are similar to Kimbrough soils in position and depth, but they are underlain by softer caliche. Available water capacity and soil fertility are low to very low.

Because these soils are droughty and erodible, they are used only as range; the stands of mid and short grasses are thin to sparse.

DRYLAND CAPABILITY UNIT VIIs-2

Only Rough broken land is in this unit. This land occupies the rugged caliche escarpment of the High Plains and the steep, thinly vegetated, highly dissected erosional part of the red-bed plains in Palo Duro Canyon. The soil material has little or no horizonation. Geological erosion is active. Available water capacity and the capacity to hold nutrients are very low.

Native vegetation is sparse, and grazing by domestic livestock is limited. This land is mainly suitable as wildlife habitat and for scenic areas such as those in the Palo Duro State Park.

Predicted Yields

Table 2 lists predicted yields of the principal crops grown in the county on both irrigated and dryland soils. The estimates are based on information taken from research data and on interviews with farmers and others who have knowledge of yields in the county. The predicted yields are average yields that can be expected over a period of years under an improved level of management.

TABLE 2.—*Predicted average yields per acre for principal soils in the county*

Soil	Wheat		Grain sorghum		Cotton (lint)	Alfalfa
	Dryland	Irrigated	Dryland	Irrigated	Irrigated	Irrigated
	Bu.	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Ton*
Acuff loam, 0 to 1 percent slopes	15. 0	55	1, 150	6, 000	850	5. 5
Acuff loam, 1 to 3 percent slopes	12. 5	50	1, 100	5, 700	800	5. 0
Amarillo fine sandy loam, 0 to 1 percent slopes	13. 0	(1)	900	(1)	(1)	(1)
Amarillo fine sandy loam, 1 to 3 percent slopes	13. 0	(1)	825	(1)	(1)	(1)
Amarillo fine sandy loam, 3 to 5 percent slopes	7. 0	(1)	700	(1)	(1)	(1)
Berda loam, 1 to 3 percent slopes	11. 0	45	1, 050	5, 500	875	5. 0
Berda loam, 3 to 5 percent slopes	9. 0	30	825	3, 800	800	4. 0
Drake soils, 1 to 3 percent slopes	9. 0	25	675	2, 000	(1)	4. 0
Lofton clay loam	14. 0	60	1, 175	6, 000	850	5. 5
Mansker clay loam, 0 to 1 percent slopes	8. 5	30	800	3, 700	725	4. 0
Mansker clay loam, 1 to 3 percent slopes	8. 0	35	750	3, 500	700	4. 0
Mansker clay loam, 3 to 5 percent slopes	8. 0	20	650	2, 700	600	3. 0
Mobeetie fine sandy loam, 3 to 5 percent slopes	6. 5	(1)	850	(1)	(1)	(1)
Olton clay loam, 0 to 1 percent slopes	15. 0	55	1, 225	6, 200	900	5. 5
Olton clay loam, 1 to 3 percent slopes	13. 0	50	1, 100	5, 200	875	5. 0
Olton clay loam, 3 to 5 percent slopes	10. 0	35	725	4, 600	700	4. 5
Pullman clay loam, 0 to 1 percent slopes	14. 0	55	1, 075	6, 000	875	5. 0
Pullman clay loam, 1 to 3 percent slopes	12. 0	45	775	5, 800	800	4. 5
Pullman clay loam, 1 to 3 percent slopes, eroded	7. 5	30	625	3, 200	(1)	3. 0
Pullman clay loam, moderately shallow, 0 to 1 percent slopes	14. 0	55	1, 075	6, 000	875	5. 0
Pullman clay loam, moderately shallow, 1 to 3 percent slopes	12. 0	45	775	5, 800	800	4. 5
Roscoe clay	13. 0	55	1, 025	5, 900	(1)	(1)
Spur clay loam	15. 0	55	1, 075	6, 200	900	5. 0
Ulysses clay loam, 0 to 1 percent slopes	13. 0	45	1, 025	5, 700	850	6. 0
Ulysses clay loam, 1 to 3 percent slopes	12. 0	35	750	3, 800	750	4. 5
Zita clay loam, 0 to 1 percent slopes	15. 0	60	1, 150	6, 500	900	6. 0
Zita clay loam, 1 to 3 percent slopes	13. 0	55	1, 075	5, 600	850	5. 0

[1] Crop is not suited to this soil, or water is not available.

In table 2 the predicted yields are given for both dryland and irrigated soils if the soils are used for dryfarming and irrigation, but if only one method is practical, yields for only this method of farming are given. Not included in table 2 are soils that are used only as range.

Wheat, grain sorghum, cotton, and alfalfa are listed in table 2 and are the principal crops grown in the county. Crops other than those shown in table 2 are grown in the county, but their predicted yields are not included because their acreage is small and reliable data on yields are not available.

In Randall County only a few farmers use the improved level of management. The improved level of management is one in which all the better methods for managing soils, plants, and water are used.

Range Management [3]

About 35 percent of the total land area in Randall County, or 208,000 acres, consists of native range. Of this rangeland the rough, broken areas of the Palo Duro Canyon make up about 80,000 acres. These areas extend east-southeast from a point just north of the town of Canyon, which is near the center of the county. Areas of gently rolling, shallow to moderately deep soils are along the Palo Duro and Tierra Blanca Creeks and their tributaries in the west-central part of the county. Also a part of the native range are the smooth, heavy soils of the High Plains on which short grasses grow. These heavy soils are generally in small areas that are used for both grazing and cropland.

Raising beef cattle is the main livestock enterprise in Randall County. Some dairy cattle and horses are also raised on small native grass pastures. Except in a few parts of the county, the most common ranching is the cow-calf type. Some stocker cattle are normally grazed on winter wheat pasture. In recent years, however, stocker steers have been carried over or purchased to graze the range when rainfall is high and forage is plentiful. They can be sold if rainfall and forage production are low. This practice provides more flexible herd management, for it meets the extreme variations in rainfall and forage production common in the county.

Range sites and condition classes

Different kinds of soils vary in their capacity to produce grass and other plants for grazing. Soils that produce about the same kind and amount of forage if the ranges are in similar condition make up a range site.

Range sites are kinds of rangeland that differ from each other in their ability to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation. *Climax vegetation* is the stabilized plant community; it reproduces itself and does not change as long as the environment remains unchanged. Throughout the prairie and the plains, the climax vegetation consists of the plants that were growing there when the region was first settled. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax type of vegetation.

[3] By HERSHEL M. BELL, field specialist on range.

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Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasers are plants in the climax vegetation that increase in relative amount as the more desirable plants are reduced by close grazing. They are commonly shorter than decreasers, and some are less palatable to livestock.

Invaders are plants that cannot withstand the competition for moisture, nutrients, and light with plants in the climax vegetation. Hence, invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many are annual weeds; some are shrubs that have some grazing value, but others have little value for grazing.

Four condition classes are used to indicate the degree of departure from the native, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in *excellent condition* if 76 to 100 percent of the vegetation is of the same kind as that in the original stand. It is in *good condition* if the percentage is 51 to 75; in *fair condition* if the percentage is 26 to 50; and in *poor condition* if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the climax for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

A primary objective of good range management is to keep rangeland in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The problem is recognizing important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of range sites

In the following pages, nine groups of soils, or range sites, are described and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential annual yield of air-dry herbage for each site when it is in excellent condition. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey. Randall clay occupies only a small acreage and consequently is not placed in a range site.

LOAMY BOTTOMLAND RANGE SITE

This range site consists of soils on alluvium along Tierra Blanca and Palo Duro Creeks and in Palo Duro Canyon. These deep, loamy soils are high in fertility, have ideal structure, and they hold large amounts of moisture available for plants. In most areas, water is received from flooding and encourages good growth of many range plants.

The climax vegetation consists of tall and mid grasses that are readily replaced by short grass under heavy grazing. Important decreasers in the climax vegetation include switchgrass, indiangrass, sand bluestem, little bluestem, and sideoats grama. The better increasers are western wheatgrass, vine-mesquite, blue grama, and silver bluestem. Buffalograss, sand dropseed, three-awn, western ragweed, and mesquite are the principal invaders. If parts of this site become saline, alkali sacaton comes in as an increaser and inland saltgrass invades.

Continuous heavy grazing by cattle has caused the site to deteriorate to the degree that the plant cover is short grasses that are dominated by weeds and low-quality grasses in many places. In the rough areas along Palo Duro Creek, the site is moderately to heavily infested with mesquite (fig. 19).

The soils on this site respond well to brush control and other good management, including deferment of grazing for one or more growing seasons and proper range use. Range seeding is effective where flooding is not a hazard, or when seedlings can be established between floods.

On this site the estimated potential yield of air-dry herbage is 2,000 pounds per acre in years of unfavorable moisture and 3,600 pounds in years of favorable moisture.

DEEP HARDLAND RANGE SITE

This range site consists of deep loamy soils that are nearly level to moderately sloping. These soils have very slow to moderate permeability. Natural fertility is high, and the hazards of soil blowing and water erosion are slight. These soils are most extensive on the High Plains. In this county most of the small native grass pastures on livestock farms are on this site.

The climax vegetation includes blue grama, vine-mesquite, western wheatgrass, and sideoats grama as decreasers. Buffalograss and silver bluestem are important increasers. The principal invaders are three-awn, sand dropseed, western ragweed, broom snakeweed, and annuals. Mesquite also invades this site, particularly in areas adjacent to the Palo Duro Canyon.

The Deep Hardland range site is likely to deteriorate under continuous heavy grazing, but a decline in condition is not so evident on this site as on other sites in the county. The decline is marked mainly by an increase in buffalograss and a decrease in blue grama. Because these grasses look alike, changes are not noticeable until the range condition has declined to poor. Then invaders are dominant, and the site appears weedy. Droughts along with heavy grazing are particularly damaging, mainly because some of the soils are clayey and hold little moisture that plants can use.

Except for proper range use, deferred grazing, and practices that conserve moisture, effective management is limited on this site. Some water spreading is practiced. Water spreading is the diversion of runoff water from gullies or water courses and the distribution of this water on adjacent range or pasture. If range condition is poor, or the soils have been plowed, the forage can be improved by seeding. Brush control is needed where mesquite has invaded.

On this site the estimated potential yield of air-dry herbage is 1,000 pounds per acre in years of unfavorable moisture and 2,200 pounds in years of favorable moisture.

Figure 19.—**Loamy Bottomland site along the Pala Duro Creek below Lake Stockton Dam. The soil is Broken alluvial land.**

SANDY LOAM RANGE SITE

This range site occurs mainly in a narrow band that is just south of Palo Duro and Tierra Blanca Creeks and extends across the county in an east-west direction (fig. 20). The site consists mainly of gently rolling soils on low ridges and adjacent foot slopes that extend into sizable areas of nearly level soils. In most places the soils are deep, fertile, and moderately to rapidly permeable. They are moderately to highly susceptible to both soil blowing and water erosion if not protected by a plant cover.

On this site the important decreasers are sideoats grama, little bluestem, and needle-and-thread, and small amounts of indiangrass, switchgrass, and sand bluestem in the more favored spots. The main increasers are blue grama, buffalograss, silver bluestem, hairy grama, three-awn, and sand dropseed. Sand sagebrush is an increasing shrub and generally competes seriously with the better grasses. Among the significant invaders are annuals and perennials, such as broom snakeweed, western ragweed, mesquite, and cactus.

Because of the large variety of forage plants on this site, careful grazing management is needed. If grazing is heavy during droughts, the climax vegetation deteriorates rapidly. Forbs and woody plants invade and make control of brush and weeds necessary. When the moisture supply is average or better, mechanical range seeding is successful. Under good management growth of forage is high, for these soils make efficient use of rainfall.

Estimated potential yield of air-dry herbage is 1,600 pounds per acre in years of unfavorable moisture and 2,800 pounds in years of favorable moisture.

MIXEDLAND SLOPES RANGE SITE

This range site consists of soils that are moderately sloping on foot slopes below the caprock escarpment of the Palo Duro Canyon and are gently sloping along the Tierra Blanca and Palo Duro Creeks. Slopes range from 3 to 12 percent. These soils are fine sandy loams that are normally deep, rich in lime, and high in fertility. They have good capacity for using moisture efficiently. If not protected, however, these soils are highly susceptible to soil blowing and water erosion.

Sideoats grama is the most important decreaser, but little bluestem and sand bluestem grow in small amounts. Palatable decreasers are blue grama, buffalograss, silver bluestem, and hairy grama, but undesirable three-awn, sand dropseed, sand sagebrush, and small yucca increase after the site deteriorates. The principal invaders are annuals, perennial forbs, and brush, including pricklypear, western ragweed, and broom snakeweed.

Yucca may increase to such an extent that it makes up as much as 25 to 30 percent of the cover where grazing has been excessive. Blue grama, a short grass, does not increase

Figure 20.—**Properly grazed area of the Sandy Loam range site. The soil is Amarillo fine sandy loam, 3 to 5 percent slopes.**

to the extent that it excludes all mid grasses. Mesquite invades only in included areas of other soils. Chemical methods are most effective in the control of invading yucca, sand sagebrush, and cactus, but these methods are not feasible unless other good management is also used. Such practices as range seeding and water control generally are not feasible.

Potential yield of air-dry herbage ranges from 1,600 pounds per acre in years of unfavorable moisture to 2,700 pounds in years of favorable moisture.

HARDLAND SLOPES RANGE SITE

The Hardland Slopes range site consists of soils that occur mainly with the soils of the Mixedland Slopes range site. These soils are moderately sloping on foot slopes to the caprock of Palo Duro Canyon and are gently sloping along Tierra Blanca and Palo Duro Creeks. Slopes range from 0 to 12 percent. Figure 21 shows a part of this range site and a typical watering facility.

The soils on the site normally are deep, loamy, and calcareous to the surface, though shallow soils make up 10 to 15 percent of the acreage. The deep soils use moisture efficiently but they are moderately susceptible to soil blowing and water erosion if they are not protected.

On this site the decreasers are sideoats grama, vine-mesquite, little bluestem, and desirable forbs. Blue grama, buffalograss, silver bluestem, three-awn, and sand dropseed are increasers. Important invaders are western ragweed, pricklypear, broom snakeweed, yucca, and annuals.

In heavily grazed areas yucca may make up as much as 10 percent of the plant cover. In some places mesquite and short grasses, such as blue grama, exclude the tall and mid grasses and are dominant on the site. Even though heavily grazed, however, this site maintains a turf and responds readily to good management. Brush control by chemical methods is needed where woody plants invade. Mechanical methods are effective in controlling mesquite. Unless mesquite is controlled, range seeding is not feasible.

On this site the estimated potential yield of air-dry herbage is 1,500 pounds per acre in years of unfavorable moisture and 2,600 pounds in years of favorable moisture.

HIGH LIME RANGE SITE

This range site consists of limy soils on mounds and ridges that are on the eastern and southeastern sides of playas in the High Plains. These soils are loamy and moderately deep. They are highly susceptible to soil blowing and water erosion and to surface crusting. In this county the acreage of these soils is small.

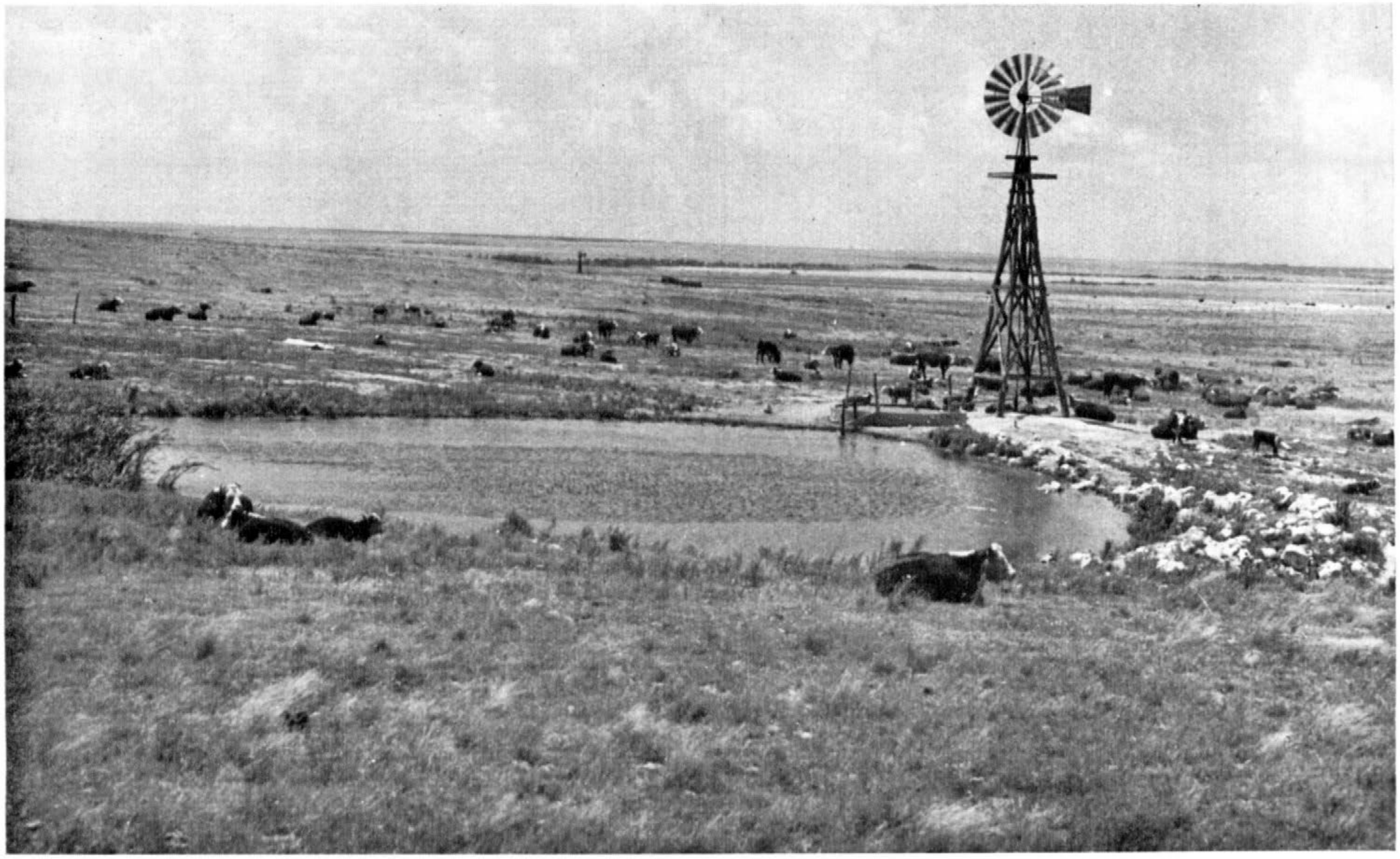

Figure 21.—**Hardland Slopes range site; the soils are Mansker and Ulysses clay loams. Except near the watering facility, range condition is good.**

The vegetation on this site is generally made up of only a few species, regardless of the degree of deterioration. Decreasers are blue grama, vine-mesquite, sideoats grama, and silver bluestem. In saline areas increasers are buffalograss, sand dropseed, and alkali sacaton. Invaders in saline areas are generally limited to sand muhly, annuals, and some yucca and inland saltgrass.

Under heavy grazing, or if the site deteriorates because of other misuse, a stand of blue grama and sideoats grama reverts to a stand of a single species, such as sand dropseed or alkali sacaton. Under continuous heavy grazing, some areas eventually become bare. Then, the soils are subject to severe soil blowing and water erosion and range improvement is more difficult.

Practices of range management other than proper grazing use are generally not feasible. Growth of forage is comparatively sparse, because the soils are so droughty.

On the site the estimated potential yield of air-dry herbage is 1,800 pounds per acre in years of favorable moisture and 1,200 pounds per acre in years of unfavorable moisture.

ROUGH BREAKS RANGE SITE

Only Rough broken land is in this range site. Much of this land type consists of the rough escarpment of the canyon walls along Palo Duro Creek. Other areas are adjacent to the stream courses of Palo Duro Creek and other drainageways where severe water erosion has cut a network of V-shaped gullies.

Normally the Rough Breaks range site is characterized by rugged, inaccessible terrain, but it has sparse stands of high-quality grasses and associated woody plants, such as redberry and blueberry juniper, sumac, mountain-mahogany, and other shrubs that are not common in the county. In some areas 75 percent of the site is bare, even though the plants generally are of high quality. Because these plants are inaccessible to livestock, composition of the vegetation is expected to remain unchanged.

In most places the decreasers are indiangrass, Canada wildrye, sand bluestem, switchgrass, little bluestem, sideoats grama, blue grama, plains bristlegrass, Arizona cottontop, vine-mesquite, and New Mexico feathergrass. The increasers are hairy grama, slim tridens, rough tridens, fall switchgrass, sand dropseed, perennial three-awn, buffalograss, and climax woody plants, such as mountain-mahogany, catclaw, skunkbush, redberry juniper, feather dalea, and hackberry.

A few annuals invade the site, but the increase in woody plants, mainly redberry juniper and mesquite, normally causes the most abuse. Little can be done to improve the site, and practices used on nearby sites have only incidental effects of this site.

On this site the estimated potential yield of air-dry herbage is 500 to 900 pounds per acre in years of favorable or unfavorable moisture, but only 25 to 50 percent of the forage is accessible to livestock.

VERY SHALLOW RANGE SITE

This range site consists mainly of soils that are very shallow over rocklike caliche. These soils are scattered throughout the county; a large acreage occurs along the steeper rims of draws. The soils are rolling to hilly and generally are between areas of deeper soils and areas of rough land.

In its normal condition, this site supports only sparse stands of native grasses. If range condition is excellent, the variety of native grasses is wide, and there are large amounts of decreaser grasses such as little bluestem, sand bluestem, indiangrass, switchgrass, Canada wildrye, and New Mexico feathergrass. Decreaser forbs are bigtop dalea, dotted gayfeather, and black sampson. Increasers include sideoats grama, hairy grama, blue grama, three-awns, rough tridens, catclaw acacia, and small yucca. Common invaders are hairy tridens, sand muhly, ring muhly, prickly pear, and redberry juniper.

When range condition is good or excellent, the vegetation is dominantly mid grasses, though lesser amounts of tall grasses grow in the more favored areas. Generally, the site does not deteriorate to the point where short grasses are dominant, but weedy or woody plants may appear dominant. On this site little treatment is feasible other than the control of redberry juniper on the more gently sloping soils.

On this site the estimated potential yield of air-dry herbage is 600 pounds per acre in years of unfavorable moisture and 1,400 pounds per acre in years of favorable moisture.

MIXEDLAND RANGE SITE

Only Quinlan-Woodward complex is in this range site. In this complex are moderately sloping to steep soils and gullied land in red-bed formations.

The climax vegetation consists mostly of mid and short grasses. Of the decreasers, sideoats grama makes up about 65 percent of the plant community and is the dominant species. Little bluestem and vine-mesquite are other important decreasers. Sand bluestem and indiangrass are dominant on slopes facing north and east, where vegetation is thicker because temperature and evaporation are less severe and more moisture is available. Common increasers on this site are blue grama, buffalograss, silver bluestem, hairy grama, three-awn, and sand dropseed. Important forbs in the climax vegetation are groundplum, milk vetch, dalea, prairie clover, scurfpea, heath aster, Engelmanndaisy, dotted gayfeather, penstemon, sagewort, and gaura. These forbs are important in that they indicate trends in range condition. Also on the site are small amounts of shrubs, such as acacia, mimosa, vine ephedra, and skunkbush.

If a source of seed is nearby, redberry juniper invades this site. Perennial grasses that commonly invade are hairy tridens, sand muhly, and tumblegrass. The chief invading forbs are broom snakeweed, false-broomweed, plains actinea, gray goldaster, wavyleaf thistle, hoary blackfoot, threadleaf groundsel, and Texas stillingia. The false broomweed invades in spots containing gypsum. Other invading forbs are common broomweed, bitterweed actinea, oneseed croton, Texas filaree, evax, plantain, and bladderpod.

On the more gently sloping, moderately deep soils, the vegetation responds to mechanical brush control. Areas disturbed by this brush control can be seeded with adapted species. Recovery of these areas is slow until the soils are stabilized and range condition is good. Then, normal response to good management can be expected.

On this site the potential yield of air-dry herbage ranges from 1,200 pounds per acre in years of unfavorable moisture to 2,000 pounds in years of favorable moisture.

Farmstead and Feedlot Windbreaks

Trees and shrubs are planted on most farmsteads and some feedlots to provide shade and a barrier against the wind and windblown snow. Trees also beautify the farmstead and provide nesting and roosting places for songbirds. Most new plants include evergreens and low shrubs that retard wind and give some protection to bobwhite quail and roadrunners.

Only a few trees are native to Randall County, and they grow mostly on bottom lands on the Spur soils. Introduced species that are planted as seedlings and watered regularly are best in upland windbreaks. Fast-growing Chinese elm and eastern redcedar and Russian-olive grow on Pullman clay loam, Olton clay loam, Zita clay loam, and other heavy soils. Chinese elm, eastern redcedar, redberry juniper, and ponderosa pine are suitable in windbreaks on Mobeetie fine sandy loam, Berda loam, and other of the sandier soils on uplands. Russian-olive, wild plum, and desert willow are among the shrubs planted in windbreaks on the sandier soils. These shrubs also provide food and cover in wildlife habitat.

Technicians assisting the Soil Conservation District or other woodland specialists are available to help in planning windbreaks by suggesting the selection of the site and the selection and spacing of the trees most adaptable for the soils on the site.

Use of the Soils for Wildlife

A large part of Randall County consists of nearly level soils on a treeless prairie, though a few intermittent streams have back cut into the landscape in an easterly direction. The rest of the county consists mainly of gently sloping to moderately sloping soils that flank the playas and draws of the High Plains. These playas and draws are interspersed with broken areas, the largest of which is the Palo Duro Canyon. About two-thirds of the county is cultivated; the rest is native grassland.

Buffalo, antelope, prairie chicken, and quail were once abundant in the county. Deer were plentiful in the rough, broken areas. Early hunters exterminated the buffalo for hides. Only a few deer and antelope now remain because, after livestock were brought in, the fields were overgrazed, fenced, and cultivated. Prairie dogs once were numerous, but they are now almost extinct.

Numerous quail, doves, and songbirds, and some predatory animals, such as coyotes, and badgers, remain in the county. Ground squirrel, jackrabbits, skunks, and other small wild animals are common. The playas, streams, and grainfields attract many ducks and geese when they are migrating. In Randall County fishing is limited to ranch ponds and lakes used for recreation. Among these lakes are Buffalo Lake, Lake Stockton, and others along the drainage system of Palo Duro Creek.

Each soil in the county is capable of producing certain plants for food and cover that meet the needs of wildlife.

Each species of wildlife requires definite kinds of food, cover, and water supply. If any one of these elements is lacking in an area, the number of wildlife tends to diminish or disappear.

Wildlife technicians of the Palo Duro Soil and Water Conservation District or personnel of the Texas Agricultural Extension Service and the Texas Park and Wildlife Department are available for assistance in developing habitats for wildlife.

The following is a brief summary of the needs of the more important kinds of wildlife in the county.

Quail and pheasant.—These nonmigratory birds require a year-round supply of food, such as seed from weeds, grasses, wild legumes, small grains, and sorghums. Quail and pheasant also eat a large number of harmful insects during spring and summer. Low-growing shrubs provide protective cover from predatory animals and also provide shade and nesting places. Weeds and shrubs and the plants in overgrown fence rows, odd areas, and field borders also provide food and cover, as well as a protective trail by which birds can move from place to place.

Several species of shrubs suitable as food and cover for quail and pheasant are suited to each soil in Randall County. Shrubs can be planted where there is a shortage of cover for wildlife. Some native shrubs furnish no cover, because they have been damaged by grazing and trampling of livestock. This damage can be prevented by fencing. Disturbing the soil, however, encourages the growth of weeds and grasses that produce good food for quail and pheasant. On the Pullman, Ulysses, Olton, and other soils suitable for cultivation, crops such as millet, sorghum, and rye can be planted to supply food. The food plants should be grown near good cover.

Ducks and geese.—Ducks and geese commonly use water areas for feeding and resting places, and they find food when they alight in surrounding cultivated fields. Both ducks and geese feed on waste grain. Geese heavily graze weeds that grow in winter and young wheat in fields. Ducks eat seed from barnyardgrass, smartweed, and similar plants that grow on margins of ponds, along streams, and in playa lakes. Randall clay, on playa floors, produces good growth of these plants if it is not overgrazed. Flooding from rains or from tail water from irrigated fields makes these lakes excellent for feeding ducks.

Deer.—Deer generally roam along the caliche escarpment and the breaks of the Palo Duro Canyon. They graze on native legumes, weeds, vines, and some grasses, and they browse on leaves, twigs, buds, and fruits of various shrubs. They also feed heavily on fields of winter wheat. Plantings of small grains on the Mansker, Ulysses, and Mobeetie soils along the breaks provide additional food for deer.

Antelope.—A few antelope roam in the Palo Duro Canyon because antelope prefer the open smooth range. Native grass, weeds, cactus, and some sagebrush are major food plants. Helpful practices in providing desirable habitat for antelope are planting of winter small grains on Spur, Berda, and similar soils near watering places and the eradication of invading brush. This planting of small grains near watering places also improves those areas.

Wildlife sites

The soils in Randall County have been placed in three wildlife sites. Each site differs in topography, kinds and amount of vegetation, kinds of wildlife that live on it, and the management required to improve the site for this wildlife or to attract other kinds. These wildlife sites are discussed in the following paragraphs.

HIGH PLAINS HARDLAND WILDLIFE SITE

This wildlife site is the most extensive one in the county. It consists of most of the soils in the Pullman, the Ulysses-Mansker, and the Olton-Amarillo soil associations, but not of the Randall and Roscoe soils, which are in the Pullman association. The soils in this site are on the broad plains but do not include the soils of the playas, or saucer-shaped depressions, that dot the landscape. Most areas are in crops. The native vegetation on range is mostly buffalograss, blue grama, western wheatgrass, and associated forbs. Chinese elm, redberry juniper, and a few other kinds of trees have been planted in windbreaks around farmsteads.

The main mammals on this site are badger, coyote, rabbit, swift fox, and skunk. The principal birds are quail, dove, pheasant, roadrunner, native sparrow, and songbirds.

PALO DURO BREAKS WILDLIFE SITE

This wildlife site consists of the soils in the Rough broken land-Potter-Quinlan-Woodward, the Mansker-Berda-Potter, the Potter-Mobeetie, and the Spur-Berda soil associations. Except for the soils in the Spur-Berda association, the soils in this site are gently sloping to steep. The Spur and Berda soils are on the narrow flood plains.

This site has a dendritic drainage system consisting of intermittent streams. Geologic erosion is active. Most areas are used for range, and a few scenic areas are used for recreation.

The native vegetation consists of short to tall grasses, such as buffalograss, blue grama, sideoats grama, black grama, bluestem, switchgrass, alkali sacaton, and associated wild legumes and forbs. Cottonwood, chinaberry, willow, and mesquite make up the main woody vegetation along the waterways.

The principal mammals on this wildlife site are antelope, deer, badger, coyote, and bobcat. The principal birds are hawk, cliff swallow, burrowing owl, eagle, and songbirds.

PLAYA WILDLIFE SITE

This wildlife site is in the Pullman association. The soils in this association that are in this site, and are of major importance to wildlife, are the Randall and Roscoe soils. These soils are of minor extent in the Pullman association. They are periodically flooded by runoff from heavy rains and in places by tail water from irrigated areas.

Dove, quail, duck, and geese are the main kinds of wildlife on this site. When the water level falls, the soils of this site produce barnyardgrass, sedges, smartweed, and other plants that provide excellent food for dove and quail. These plants also provide food for duck and geese when the soils are flooded. Pheasants and ducks find nesting places in some parts of this site.

Engineering Uses of Soils [4]

Soils are used in engineering mainly to support structures and as construction material in the structure itself.

[4] By DAN C. HUCKABEE, area engineer, Soil Conservation Service.

Soil materials are used in the construction of roads and airports; to support buildings, pipelines, or drainage systems; in structures for water storage, erosion control, sewage disposal, or irrigation; and for many other uses. The soil properties most important to the engineer are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell potential, grain size, plasticity, and soil reaction (pH). Also important are depth to the water table, depth to bedrock, and topography.

The information in this survey can be used by engineers to—

1. Make studies of soil and land use that will aid in selecting and developing sites for industrial, business, residential, and recreational uses.
2. Make preliminary estimates of the engineering properties of soils in the planning of agricultural drainage systems, farm ponds, irrigation systems, and diversion terraces.
3. Make preliminary evaluations of soil and ground conditions that will aid in the selection of locations for highways, airports, pipelines, and cables and in planning detailed investigations at the selected sites.
4. Locate probable sources of gravel and other materials used in construction.
5. Correlate performance of engineering structures with soil mapping units and thus develop information that will be useful in designing and maintaining the structures.

TABLE 3.—*Estimated engineer-*

Soil series and map symbols	Depth from surface	Classification		
		USDA texture	Unified [1]	AASHO [2]
	Inches			
Acuff (AcA, AcB).	0–10	Loam	CL	A–6
	10–85	Sandy clay loam	CL or SC	A–6
Amarillo (AmA, AmB, AmC).	0–11	Fine sandy loam	CL or SC	A–6
	11–68	Sandy clay loam	CL or SC	A–6
	68–96	Very fine sandy loam	CL or SC	A–6
Berda (BeB, BeC, BeD).	0–45	Loam	CL	A–6
	45–60	Clay loam	CL	A–6
Drake (DrB, DrD).	0–60	Clay loam	CL	A–6
Kimbrough (Ke).	0–8	Loam	ML or CL	A–4
(For properties of the Lea soils, refer to the Lea series.)	8–36	Hard platy caliche		
Lea.	0–7	Loam	ML or CL	A–4
(Mapped only with the Kimbrough series.)	7–22	Clay loam	CL	A–6
	22–40	Hard platy caliche		
Lofton (Lo.)	0–8	Clay loam	CL	A–6
	8–60	Clay	CH	A–7
Mansker (MkA, MkB, MkC, MkC2, MkD).	0–9	Clay loam	CL	A–6
	9–56	Clay loam	CL	A–6
Mobeetie (MrC, MrD).	0–10	Fine sandy loam	ML or SC	A–4
	10–52	Sandy clay loam and fine sandy loam.	SC or CL	A–6
Olton (OcA, OcB, OcC).	0–15	Clay loam	CL	A–6
	15–31	Clay loam	CL or CH	A–6 or A–7
	31–96	Clay loam	CL	A–6
Potter (Pe).	0–9	Gravelly loam	ML or CL	A–4
	9–40	Caliche		
Pullman (PmA, PmB, PmB2, PuA, PuB).	0–6	Clay loam	CL	A–6
	6–46	Clay	CH	A–7
	46–62	Clay loam	CL or CH	A–7
	62–90	Clay loam	CL	A–6
Quinlan (Qw).	0–6	Very fine sandy loam	CL or SC	A–6
(For properties of Woodward soils, refer to the Woodward series.)	6–18	Soft sandstone.		
Randall (Ra).	0–50	Clay	CH	A–7
	50–100	Clay loam	CL or CH	A–7

See footnotes at end of table.

6. Determine the suitability of soils for the cross-country movement of vehicles and construction equipment.
7. Supplement the information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

The engineering interpretations in this subsection can be useful for many purposes, but it should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Even in these situations, however, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms used by the soil scientists may not be familiar to the engineer, and some terms may have a special meaning in soil science. Several of these terms are defined in the Glossary at the back of this survey.

Although most of the information in this subsection is in tables 3 and 4, additional information useful to engineers can be found in other sections of this soil survey, particularly "Descriptions of the Soils" and "Formation and Classification of Soils."

ing properties of the soils

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
			Inches per hour	*Inches per inch of soil*	*pH*	
100	95–100	60–70	0. 8–2. 5	0. 17	7. 4–7. 8	Low to moderate.
100	90–100	45–65	0. 8–2. 5	0. 17	7. 4–7. 8	Low to moderate.
100	95–100	40–60	0. 8–2. 5	0. 14	6. 6–7. 3	Low.
100	95–100	45–65	0. 8–2. 5	0. 15	7. 4–7. 8	Low to moderate.
100	95–100	40–55	0. 8–2. 5	0. 15	7. 4–7. 8	Low to moderate.
100	95–100	60–70	0. 8–2. 5	0. 15	7. 4–7. 8	Low to moderate.
100	95–100	70–80	0. 8–2. 5	0. 16	7. 4–7. 8	Low to moderate.
100	95–100	70–80	0. 8–2. 5	0. 15	7. 9–8. 4	Low to moderate.
100	95–100	60–70	0. 8–2. 5	0. 10	7. 9–8. 4	Low.
---	---	---	---	---	7. 9–8. 4	
100	95–100	60–70	0. 8–2. 5	0. 17	7. 4–7. 8	Moderate.
100	95–100	70–80	0. 8–2. 5	0. 18	7. 9–8. 4	Moderate.
---	---	---	0. 8–2. 5	---	7. 9–8. 4	
100	95–100	70–80	0. 2–0. 8	0. 20	6. 6–7. 3	Moderate.
100	100	75–95	0. 05–0. 2	0. 18	7. 4–7. 8	High.
100	95–100	70–80	0. 8–2. 5	0. 15	7. 9–8. 4	Low to moderate.
100	95–100	70–80	0. 8–2. 5	0. 15	7. 9–8. 4	Low to moderate.
100	90–100	40–55	0. 8–2. 5	0. 13	7. 4–7. 8	Low.
100	90–100	45–65	0. 8–2. 5	0. 13	7. 4–7. 8	Low to moderate.
100	95–100	70–80	0. 2–0. 8	0. 17	6. 6–7. 3	Moderate.
100	95–100	90–95	0. 2–0. 8	0. 17	6. 6–7. 3	High.
100	95–100	70–80	0. 2–0. 8	0. 17	7. 4–7. 8	Moderate to high.
90–100	85–95	50–60	0. 8–2. 5	0. 15	7. 9–8. 4	Low to moderate.
---	---	---	---	---	7. 9–8. 4	
100	95–100	85–95	0. 2–0. 8	0. 18	6–6. 7. 3	Moderate to high.
100	95–100	85–95	0. 2–0. 8	0. 18	7. 4–7. 8	High.
100	95–100	90–95	0. 2–0. 8	0. 17	7. 9–8. 4	High.
100	95–100	85–95	0. 2–0. 8	0. 17	7. 9–8. 4	Moderate.
100	95–100	45–60	2. 5–5. 0	0. 06	7. 9–8. 4	Low.
100	95–100	80–95	<0. 05	0. 20	6. 6–7. 3	Very high.
100	95–100	75–85	0. 05–0. 2	0. 19	7. 4–7. 8	Moderate to high.

TABLE 3.—*Estimated engineer-*

Soil series and map symbols	Depth from surface	Classification		
		USDA texture	Unified [1]	AASHO [2]
	Inches			
Roscoe (Rc).	0–56	Clay	CH	A–7
	56–90	Silty clay	CH	A–7
Spur (Sb, Sc).	0–18	Clay loam	ML	A–4
	18–45	Clay loam	CL	A–6
	45–60	Silty clay loam	CH	A–7
Ulysses (UcA, UcB).	0–30	Clay loam	CL	A–6
	30–84	Silty clay loam and clay loam.	CL or CH	A–6 or A–7
Woodward. (Mapped only with the Quinlan series.)	0–20	Very fine sandy loam	CL	A–6
	20–36	Very fine sandy loam	CL	A–6
Zita (ZcA, ZcB).	0–66	Clay loam	CL	A–4

[1] Based on the Unified Soil Classification System (*10*), Tech. Memo. No, 3–357, 2 v., Waterways Experiment Station, Corps of Engineers.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as source of—		Soil features adversely affecting—	
			Farm ponds	
	Topsoil	Road fill	Reservoir area	Embankment
Acuff (AcA, AcB)	Good	Good	Moderate seepage	No unfavorable features
Amarillo (AmA, AmB, AmC)	Good	Good	Moderate seepage	No unfavorable features
Berda (BeB, BeC, BeD)	Fair	Fair	Seepage hazard	No unfavorable features
Drake (DrB, DrD)	Poor	Fair	Moderate seepage	No unfavorable features
Kimbrough (Ke). (For interpretations of the Lea soils, refer to the Lea series.)	Poor	Topsoil unsuitable; substratum good.	Soil very shallow over indurated caliche; seepage hazard.	Soil very shallow over indurated caliche; poor stability.
Lea. (Mapped only with the Kimbrough series.)	Fair	Fair	Seepage hazard; moderately shallow over indurated caliche.	Soil moderately shallow over indurated caliche; stability questionable.
Lofton (Lo)	Fair	Poor	No unfavorable features	Fair stability; high shrink-swell potential in subsoil.
Mansker (MkA, MkB, MkC, MkC2, MkD)	Fair	Good	Seepage hazard	No unfavorable features
Mobeetie (MrC, MrD)	Fair	Fair	Seepage hazard	No unfavorable features

ing properties of the soils—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
			Inches per hour	*Inches per inch of soil*	*pH*	
100	95–100	75–95	0. 05–0. 20	0. 18	7. 4–7. 8	High to very high.
100	95–100	85–95	0. 2–0. 8	0. 20	7. 9–8. 4	High.
100	95–100	65–75	0. 2–0. 8	0. 12–0. 15	6. 6–7. 3	Low.
100	95–100	70–80	0. 2–0. 8	0. 15–0. 17	7. 4–7. 8	Moderate.
100	100	85–95	0. 2–0. 8	0. 15–0. 17	7. 4–7. 8	Moderate to high.
100	95–100	70–85	0. 2–0. 8	0. 16	7. 9–8. 4	Moderate.
100	95–100	90–95	0. 2–0. 8	0. 16	7. 9–8. 4	Moderate to high.
100	95–100	50–65	0. 8–2. 5	0. 14–0. 16	7. 4–7. 8	Low to moderate.
100	95–100	50–65	0. 8–2. 5	0. 14–0. 16	7. 9–8. 4	Moderate.
100	95–100	70–80	0. 8–2. 5	0. 17	6. 6–7. 8	Moderate.

[2] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1; Ed. 8): The Classification of Soil and Soil Aggregate Mixtures for Highway Construction Purposes AASHO Designation M 145–49 (*1*).

interpretations of soils

Soil features adversely affecting—Continued				
Irrigation	Terraces and diversions	Waterways	Highway location	Building foundations
No unfavorable features	No unfavorable features	No unfavorable features	No unfavorable features	No unfavorable features.
No unfavorable features	No unfavorable features	No unfavorable features	No unfavorable features	No unfavorable features.
Hazard of erosion; moderate to strong slopes.	Slopes generally not suitable for terraces.	Moderate to strong slopes; subject to erosion.	Subject to water erosion	No unfavorable features.
Hazard of erosion; moderately sloping to sloping.	Subject to soil blowing if not protected.	Subject to soil blowing and water erosion.	Subject to soil blowing and water erosion.	High lime content.
Soil very shallow over indurated caliche.	Soil very shallow over indurated caliche.	Soil very shallow over indurated caliche.	Soil very shallow over indurated caliche.	No unfavorable features.
Soil moderately shallow over indurated caliche.	Soil moderately shallow over indurated caliche.	Soil moderately shallow over indurated caliche.	Soil moderately shallow over indurated caliche.	No unfavorable features.
Slow intake rate	No unfavorable features	No unfavorable features	High shrink-swell potential in subsoil.	Poor stability; high shrink-swell potential in subsoil.
Soils moderately shallow over caliche; low water-holding capacity.	Soils moderately shallow over caliche.	Soils moderately shallow over caliche.	Soils moderately shallow over caliche.	Soils moderately shallow over caliche.
Hazard of erosion; moderate to strong slopes.	Slopes generally unsuitable for terraces.	Hazard of erosion; moderate to strong slopes.	Hazard of water erosion; moderate to strong slopes.	No unfavorable features.

TABLE 4.—*Engineering*

Soil series and map symbols	Suitability as source of—		Soil features adversely affecting—	
			Farm ponds	
	Topsoil	Road fill	Reservoir area	Embankment
Olton (OcA, OcB, OcC)	Good	Fair	No unfavorable features	Moderate stability; moderate shrink-swell potential in surface layer; high shrink-swell potential in subsoil.
Potter (Pe)	Poor	Fair	Seepage hazard; very shallow over caliche.	Soils very shallow over caliche; poor stability.
Pullman (PmA, PmB, PmB2, PuA, PuB)	Good	Poor	No unfavorable features	Poor stability; high shrink-swell potential in subsoil.
Quinlan (Qw) (For interpretations of Woodward soils, refer to the Woodward series.)	Fair	Fair	Seepage hazard	No unfavorable features
Randall (Ra)	Poor	Poor	Subject to flooding	Very high shrink-swell potential; poor stability.
Roscoe (Rc)	Poor	Poor	Subject to occasional flooding.	Poor stability; high to very high shrink-swell potential.
Spur (Sb, Sc)	Good	Fair	Subject to occasional flooding.	No unfavorable features
Ulysses (UcA, UcB)	Good	Fair	No unfavorable features	No unfavorable features
Woodward (Mapped only with the Quinlan series.)	Fair to good	Fair to poor	Moderate to slight seepage hazard.	No unfavorable features
Zita (ZcA, ZcB)	Good	Good	Moderate seepage hazard.	No unfavorable features

Engineering classification systems

Most highway engineers classify soil materials according to the AASHO system (*1*). In this system, the soils are placed in seven basic groups, designated A–1 through A–7. In group A–1 are gravelly soils of high bearing capacity, or the best soils for road subgrade. In group A–7 are the poorest soils, clays that have low strength when wet. Groups A–1, A–2, and A–7 can be further divided to indicate more precisely the nature of the soil material.

In the Unified classification, the soils are grouped on the basis of their texture and plasticity and their performance as material for engineering structures. Soil materials are identified as gravels (G), sands (S), silts (M), clays (C), organic (O), and highly organic (Pt). Clean sands are identified by the symbols SW and SP; sands mixed with fines of silt and clay are identified by the symbols SM and SC; silts and clays that have a low liquid limit are identified by the symbols ML and CL; and silts and clays that have a high liquid limit are identified by the symbols MH and CH.

The United States Department of Agriculture classifies soils according to texture, which is determined by the proportion of sand, silt, and clay in the soil material (*7*). The terms "sand," "silt," and "clay" are defined in the Glossary at the back of this survey.

Engineering properties of the soils

Estimates of properties significant to engineering are given in table 3 for the soils in Randall County. Used as a basis for these estimates were engineering test data on soils in nearby counties, information taken from other parts of this soil survey, and other knowledge about individual soils in the county. Estimates are not given for Broken alluvial land and Rough broken land, since these land types are variable.

In the columns under "Classification" the soil layers designated under "Depth from surface" are classified accord-

interpretations of soils—Continued

Soil features adversely affecting—Continued				
Irrigation	Terraces and diversions	Waterways	Highway location	Building foundations
Moderate intake rate; generally suited to surface irrigation.	No unfavorable features	No unfavorable features	High shrink-swell potential in subsoil.	High shrink-swell potential in subsoil.
Not suitable; very shallow over caliche.	Soils very shallow over caliche.	Soils very shallow over caliche.	Soils very shallow over caliche.	Soils very shallow over caliche.
Slow intake rate	No unfavorable features	No unfavorable features	High shrink-swell potential in subsoil.	High shrink-swell potential in subsoil.
Soil very shallow over bedrock; sloping to steep; very high intake rate; hazard of erosion.	Soils very shallow over bedrock.	Soils very shallow over bedrock; sloping to steep.	Soils sloping to steep	No unfavorable features.
Slow intake rate; subject to flooding.	Flooding hazard; terraces and diversions not needed.	Not needed	Subject to flooding	Subject to flooding; very high shrink-swell potential.
Slow intake rate; subject to occasional flooding.	Not needed	Not needed	Subject to occasional flooding: high to very high shrink-swell potential.	Subject to occasional flooding; high to very high shrink-swell potential.
Subject to occasional flooding.	Not needed	Not needed	Subject to flooding from time to time; water table may affect stability.	Subject to occasional flooding; water table.
No unfavorable features	No unfavorable features	No unfavorable features	No unfavorable features	No unfavorable features.
Moderate to slow permeability.	No unfavorable features	No unfavorable features	Strongly calcareous subsoil; moderately deep over caliche.	No unfavorable features.
No unfavorable features	No unfavorable features	No unfavorable features	No unfavorable features	No unfavorable features.

ing to the USDA textural classification and the Unified and AASHO engineering classifications.

The columns headed "Percentage passing sieve," list estimates for soil materials passing sieves of three sizes. This information is useful in helping to determine suitability of the soil as material for construction purposes.

Permeability of a soil, as shown in table 3, is the ability of the soil to transmit water. Permeability was estimated for each soil as it occurs in place. The estimates were based on soil structure and porosity and were compared with the results of permeability tests on undisturbed samples of similar soils.

Available water capacity, given in inches of water per inch of soil, refers to the amount of water that a soil can hold, or the amount needed to saturate the soil when moisture content is at about the lowest point to which it can be reduced by growing crops. When moisture is at this point, or the permanent wilting point of plants, this amount of water will wet the soil material to a depth of 1 inch without deeper percolation. For example, a layer of Pullman soil that has clay loam texture and is 1 inch thick holds 0.18 inch of available water when wetted to field capacity.

Reaction refers to the degree of acidity or alkalinity and is expressed in pH values of the soil. The pH value indicates the corrosiveness of the soil solution and the protection needed when pipelines and similar structures are placed in the soil.

The shrink-swell potential indicates the change in volume that occurs in a soil material when the moisture content changes. In general, clayey soils have a high shrink-swell potential and are likely to be risky if used for engineering structures.

Engineering interpretations

In table 4 the soils of Randall County are rated as sources of material for engineering uses. Also given are features that adversely affect the suitability of each soil

as a site for engineering structures. The features for a given soil were based on the modal profile of that soil, as given in table 3. Variations in the profile may change the ratings of the soil. Because Broken alluvial land and Rough broken land are variable, interpretations are not given for them.

Suitability of soil material for topsoil is rated for the various soils in the county in table 4. In this county the soils are rated poor or fair as a source of topsoil, because they are eroded and low in content of organic matter. Also topsoil in Randall County is heavy, sticky, and difficult to handle or work. Most of the soils in the county are so clayey that they are not suited as a source of sand and gravel.

Suitability of a soil for road fill depends largely on its texture, plasticity, shrink-swell potential, traffic-supporting capacity, susceptibility to erosion, compaction characteristics, and natural water content. Clayey soils, such as Randall clay and Roscoe clay, have high or very high shrink-swell potential. They are rated poor as a source of road fill, because they generally are difficult to place and compact.

Stability is a problem when Randall clay and Roscoe clay are used for embankments for farm ponds. These soils crack when dry and swell much when wet. Also, reservoir areas and embankments for farm ponds are impaired by bedrock near the surface, frequent flooding, and very permeable soil material.

Suitability of the soils for irrigation depends largely on rate of intake, water-holding capacity, soil depth, slope, susceptibility to water erosion, and the flooding hazard. For example, irrigation farming is risky on frequently flooded areas of Spur clay loam, broken.

Soil features that affect suitability of a soil when used for terraces or diversions are slope, texture, stability of soil material, and depth to bedrock or other unfavorable material. For example, field terraces constructed on sloping, erosive, or very shallow soils are difficult to build and maintain. Potter soils are an example of soils not suited to terraces or diversions.

Grassed waterways are used on soils to carry off water from terrace outlets, diversion outlets, and other areas. Soils that are shallow to hard caliche are poorly suited as sites for grassed waterways, for the soils are droughty and vegetation is difficult to establish on them. Also, caliche makes construction difficult. The Potter soils and Kimbrough soils are examples of soils that are very shallow to weakly cemented or indurated caliche.

Location of highways is influenced by the relief and the kind and amount of material available for road building. Excessively deep cuts and fills increase costs of construction. Rough broken land is an example of the kind of material unsuitable for highway location.

Building foundations are adversely affected where they are set in clays that have high to very high shrink-swell potential. Randall clay and Roscoe clay are not suitable as sites for homes or industrial buildings. The use of Randall clay and Roscoe clay as sites for homes and industrial buildings is hazardous because foundations crack and these soils are temporarily flooded.

Suitability of soil associations for engineering structures

Suitability of soils for engineering use is generally reflected in the various patterns of soils, or soil associations, in the county. These associations are described in the section "General Soil Map" and are shown in color on a map at the back of the survey. In the following paragraphs important characteristics that affect engineering are discussed so as to assist in the selection of sites suitable for engineering structures.

1. *Pullman association.*—Soil materials in this association are generally suitable for farm ponds, terraces, waterways, diversions, and other earthen structures. In most places a layer of caliche, 2 to 3 feet thick, occurs at a depth of 3 to 5 feet. In these places material other than caliche is needed for sealing excavated ponds or reservoirs. The maintenance of earthen structures is difficult because the soils in most of this association have a subsoil with high shrink-swell potential. Channel-type terraces and diversions work well where suitable outlets are available.

2. *Ulysses-Mansker association.*—Soils in this association generally have a loamy surface layer and are underlain by material containing caliche. Some sites are suitable for ponds. Ponds function well if care is taken when coring and scarifying at the site of the dam. Sealing is needed in the reservoir area. Spillways are difficult to construct because the soils in most areas are erodible. Grassed waterways, terraces, and diversions generally are suitable in this association, but soil blowing is common in all areas. Irrigation is practical in areas where wells that produce enough water can be drilled. Most of the water in this association is of good quality.

3. *Olton-Amarillo association.*—The soils in this association generally are suitable for farm ponds, terraces, waterways, diversions, and other earthen structures. Reservoirs or excavated ponds function well where damaging sediments do not accumulate. Construction of spillways for ponds and similar structures is not so difficult in this association as in other parts of the county. Where suitable outlets are available, channel-type terraces and diversions are satisfactory. Irrigation is suitable where wells produce enough water of good quality.

4. *Rough broken land-Potter-Quinlan-Woodward association.*—Dominant in this association are Rough broken land and stony areas. The underlying material is mostly caliche and red beds, but many areas of caliche are not accessible. Also, the soft caliche in areas of Potter soils and Rough broken land is not good construction material. In this association sand and gravel do not occur in amounts large enough for commercial use.

5. *Mansker-Berda-Potter association.*—Soils of this association are on the side slopes along the draws of Palo Duro and Tierra Blanca Creeks. They are in an area between the caliche escarpments of the High Plains and the valley floor. The soils in this association are not suitable as sites for engineering structures, because they are too steep, highly erosive, and in many places are very shallow.

6. *Potter-Mobeetie association.*—These soils are similar to the soils in the Mansker-Berda-Potter association, but

they have steeper slopes and generally are coarser textured. Structure is weak and has little significance.

7. *Spur-Berda association.*—Soils in this association are suitable for dams for ponds and reservior areas, but generally construction is not feasible, because drainageways bring in much sediment. The bottoms of the drains normally are covered by an accumulation of sand and loamy materials. Seepage may be considerable unless care is taken in coring the dam across the drainageway. In the areas between the drainageways are nearly level, loamy soils suitable for cultivation.

Use of soils in community development

Population and community development in and around Randall County have greatly increased in the past decade and are continuing to increase, particularly between Amarillo, in Potter County, and Canyon, in Randall County. Also, many resorts, estate homes, and camps have been built in the Palo Duro Valley and in smaller adjacent valleys. As building in this county increases, public utilities are extended and recreational facilities are established. Somewhat different information about soils is required in planning for community development than is needed for farming. This medium-intensity survey of Randall County provides information that helps in selecting sites for community developments, though for many purposes more detailed soil investigations are needed.

The physical properties of the soil and topography of its landscape determine suitability for specific uses. For most nonfarm uses, steep slopes are less desirable than gentle ones. Soils that are flooded or are wet for extended periods, such as Randall clay on playa floors, can be used for wild ducks and geese, but for little else. Draining Randall clay or diverting water from it may be practical, but the very high shrink-swell potential of the clay makes the soil unfit for building foundations or for fill material in highways. Slopes are also a limitation unless the soil is leveled by heavy earthmoving equipment.

Pullman clay loam, the most extensive soil in the county, makes up much of the area between Canyon and Amarillo. Nonfarm uses of this soil are limited by the subsoil consisting of compact clay that has high shrink-swell potential. Shrinking and swelling have caused early failure of concrete irrigation pipelines laid in the subsoil of Pullman clay loam, but those laid in the substratum are satisfactory. Foundations of houses or larger buildings likely will fail if they are set in the subsoil of a Pullman soil, but they are satisfactory in the substratum.

Although not so extensive as Pullman soils, Roscoe and Randall soils are deeper, contain more clay, and have greater shrink-swell potential. Sewerlines and waterlines laid at shallow depths have failed in the Roscoe and Randall soils. Also, the shrinking and swelling of the heavy clay have caused poles for powerlines to move out of line, pavements to break, and building foundations to rise and fall.

Soils that are wet most of the time or that are subject to flooding are severely limited as sites for septic tank disposal systems. The slowly permeable subsoil of Pullman, Olton, Roscoe, and other soils does not permit proper functioning of these disposal systems. Sandy and moderately sandy soils that are moderate to rapid in permeability are needed.

On homesites and in other areas grasses, trees, and shrubs are needed for landscaping. During droughts, grass grows better on sandy or loamy soils than it does on heavy clays. The heavy clayey soils are more fertile, but they require more frequent wetting. The cracking of the surface layer of the clays, and the resulting evaporation of moisture, can be reduced by adding fine sandy loam, loam, or organic material. The kinds and amounts of vegetation suitable for saline or alkaline soils are limited. Shrubs and trees can be grown on most soils suitable for community development if the soils are irrigated and fertilizer is added.

Geology

The origin of the High Plains is significant in the geologic history of Randall County (*4*, *5*). About 200 million years ago, a shallow sea covered a large area that included most of the Panhandle of Texas, the eastern part of New Mexico, and the western part of Oklahoma (*3*). Marine sediments deposited during this period formed the Permian red beds that later rose above the level of the sea. The streams flowed over the exposed Permian rocks, eroded them, and redeposited fine-textured materials along the flood plains. These materials formed the Triassic red beds. Exposures of these formations can be seen at a short distance below the caliche escarpments in the Palo Duro Canyon. These exposures are ledges and bluffs consisting of reddish-brown shale and grayish-brown sandstone.

During the Cretaceous period, a shallow arm of the seas again partly covered the High Plains. Silty clay and sand were deposited on much of the area.

While the Rocky Mountains were forming, swift streams from the mountains cut valleys and canyons through the Cretaceous and Triassic rocks and into the Permian rocks. Most of the Cretaceous deposits, and in places all of the Triassic deposits, were washed toward or into the Gulf of Mexico. When the mountains were near their maximum height, they began to erode severely. As erosion continued, the streams slowed considerably at the foot of the steep slopes and large amounts of gravel, sand, and silt were deposited. These deposits formed a massive fan of coarse gravelly materials along the foot slopes of the mountains and eastward onto the plains. The gravelly materials were the first deposits of the Ogallala formation, and they are the present water-bearing stratum.

Following the gravelly materials were finer textured sand and calcareous, loamy materials. These deposits gradually raised the surface as much as 600 feet, or nearly to the present level of the High Plains (*3*). They formed a vast plain that extended several hundred miles east of the Rockies. Exposures of this very extensive Ogallala formation can be seen along the escarpment of the Palo Duro Canyon and tributary canyons and along some draws. Most areas of the Potter soils have developed in these deposits.

The glaciers did not reach as far south as Randall County, but they made the climate cool and humid. Because precipitation was heavy, a few large rivers and val-

leys formed. The rivers are the Canadian, Cimarron, and Arkansas to the north, the Pecos to the west, and the Red to the south. All of these rivers have cut through the Cenozoic and Triassic deposits, and in some places have cut deeply into the Permian deposits.

The next important geologic event was the formation of the eolian mantle on the High Plains. The deposits, called cover sands, range from a few feet to more than 100 feet in thickness (*5*). The eolian mantle was deposited about the middle of the Pleistocene epoch. By that time the climate was reversed and was dry, windy, and erosive. The prevailing winds were from the southwest. They blew fine-textured sediments from the river bottom, carried them to the northeast, and redeposited them on the High Plains over the Ogallala formation. Formed in these fine-textured sediments were the Pullman, Olton, Zita, Amarillo, and most other soils of the High Plains. The most recent geologic formations in this county are the inextensive alluvial deposits along the stream bottoms of the Palo Duro watershed and along Cita Creek. These deposits were probably laid down from Late Wisconsin to Recent geologic age.

At present, geologic erosion is wearing away the edges of the High Plains tableland. Consequently, the rough land of the Palo Duro Canyon and its tributary canyons is slowly advancing into the High Plains.

The underground water used for irrigation in Randall County comes from the saturated sand and gravel in the lower part of the Ogallala formation. This water probably accumulated during the wet period when the formation was being laid down. The underlying red beds kept the water from percolating to a greater depth. Later, the Ogallala formation was cut off from the Rocky Mountains by the Pecos River and by the Canadian River to the north, and its source of recharge water was lost. Apparently, there is little or no recharge from local rainfall.

The amount of water available for irrigation varies according to the thickness of the sands and gravel in the Ogallala formation and the depth to the red beds. It also varies according to the amount of water that has been pumped for irrigation and has not been replaced by recharge. In Randall County water is being pumped much faster than it is being replaced. Representatives of the High Plains Underground Water District have been studying the fall in the water table by observing selected wells. They reported that, from 1959 through 1963, in 13 wells, there was an average drop of 8.27 feet, or 1.65 feet per year. Observation of 36 wells showed an average drop of 2.54 feet in 1964.

In Randall County practically all of the irrigation water is taken from wells drilled into the Ogallala formation in two large areas. One of these areas extends from Tierra Blanca and Palo Duro Creeks northward and westward to the northern and western boundaries of the county; the other area is in the southern and southeastern parts of the county.

Formation and Classification of Soils

This section explains how soils form and discusses the factors that affected the formation of soils in Randall County. It describes briefly the current system of soil classification and places the soil series represented in the county in some classes of that system. Also in this section is a discussion of important chemical and mineralogical characteristics of the soils.

Factors of Soil Formation

Soil is the product of the interaction of the five major factors of soil formation. These factors are climate, living organisms (especially vegetation), parent material, relief, and time. They all come into play in the genesis of every soil.

The relative importance of each factor differs from place to place. In some areas one factor may dominate in the formation of a soil and fix most of its properties in extreme instances, as is common when the parent material largely consists of quartz sand. Quartz sand is highly resistant to weathering and the soils derived from it usually have faint horizons. Even in quartz sand, however, a distinct profile can form under certain kinds of vegetation where the topography is low and flat and the water table is high.

Climate

Precipitation, temperature, and wind have been important in the development of the soils of Randall County. The wet climate of past geologic ages influenced the deposition of parent materials. Later, rainfall was limited, and it seldom wet the soil below the area of living roots. As a result horizons of calcium carbonate formed in most of the mature soils, such as the Pullman, Olton, and Amarillo. Precipitation has been so limited that it has not leached free lime from the young soils, such as those of the Mansker and Ulysses series.

The mild temperature in the county has influenced the kinds and growth of organisms in and on the soils. It has also encouraged chemical reactions. In this county freezing and thawing have had little effect on weathering and the soil-forming processes.

Wind has affected development of soils in this county by depositing silts and sands on the land surface in the Pleistocene epoch and to the present. The wind continues to affect developing by shifting sand, silt, and clay on the exposed surfaces.

Living organisms

Vegetation, micro-organisms, earthworms, and other organisms that live on and in the soil contribute to its development. The kinds and amounts of vegetation are important. They are determined partly by the climate and partly by the kind of parent material. Climate limited the vegetation in Randall County to grass. The parent material determined whether the grass would be tall, as on the fine sandy loams of the Mobeetie series, or short, as on the clay loams of the Pullman series.

The mixed prairie-type of native vegetation contributed large amounts of organic matter to the soil. Decaying grass, leaves, and stems were distributed on the soil surface. When the roots in the soils decayed, they left a network of tubes and pores, which helped air and water to pass through the soil. The roots themselves were a source of abundant food for bacteria, actinomycetes, and fungi.

Earthworms are the most noticeable form of animal life in the soils of Randall County. Worm casts add to the movement of air, water, and plant roots in the soil.

The subsoil of the Ulysses, Mansker, Zita, and Berda soils is largely made up of worm casts.

Rodents have had a part in the development of some soils. These burrowing animals did much to offset the leaching of free lime from the soil, but they also destroyed soil structure. This can be seen in the profile of Ulysses soils that occur within large areas of Pullman soils. In contrast to the undisturbed Pullman soils around them, the Ulysses soils are calcareous to the surface, have weaker structure in the subsoil, and have a weaker Cca horizon in many places.

In the past 50 years, the activities of man have considerably affected the soils of this county. At first he fenced the range and allowed it to be overgrazed. As a result the vegetation changed. He then plowed the soils and planted crops. The harvesting of crops encouraged runoff and wind erosion and reduced the amount of organic matter and the proportion of silt and clay particles in the plow layer. By timing tillage poorly and using heavy machinery, man compacted the soils and reduced aeration and infiltration of water. He changed the moisture supply in some areas by irrigation. All of these changes will be reflected in the future direction and rate of development of the soils.

Parent material

Parent material, particularly its texture and content of lime, greatly influences soil development. Soils that developed from fine-textured material generally formed more rapidly and to a greater degree than soils formed in coarse-textured material. The parent material of the soils of Randall County is dominantly strongly calcareous and moderately alkaline, unconsolidated sandy and silty clay material. It was derived mostly from loessal deposits and from Rocky Mountain outwash, part of which has been reworked by wind. The geology of the parent material is discussed in more detail in the section "Geology."

Relief

Relief influences soil development through its influence on drainage, erosion, plant cover, and soil temperature. The degree of profile development depends to a large extent on the average amount of moisture in the soil. Steep soils, such as the Potter, absorb less moisture, are more susceptible to erosion, and have a less developed profile than the Olton and similar soils on smooth, gentle slopes. On the steeper slopes soil material is carried away by continuous erosion almost as fast as it forms. Randall soils in depressions, or playas, formed in heavy clay. These soils show only slight profile development, because they have very poor drainage and have deep self-mulching characteristics. The prevailing southwesterly winds have deposited soil material on slopes facing northeast but have removed soil material from slopes facing southwest. In many areas, therefore, the soils are deeper and more strongly developed on slopes facing north and northeast.

Relief also affects the kinds and amounts of plant cover on a soil, though this effect is not great in Randall County. Slopes facing north and northwest are sheltered from the drying prevailing southwesterly winds and receive less direct sunlight than slopes facing south. Because the soils on slopes facing north and northwest lose less moisture through evaporation and melting snow, they generally produce more vegetation than soils on slopes facing south.

Time

The length of time that climate, living organisms, and relief have acted on parent material affects the kind of soil that develops, but the effects of time are modified by the other four factors of soil formation. Soils that do not have clearly expressed horizons are considered immature, and those that have well-expressed horizons are considered mature.

Soils formed in recent alluvium, such as Spur clay loam, are immature because the alluvium has not been in place long enough for a distinct profile to form. The steep Potter and Mansker soils are immature because geologic erosion has removed developed soil material. Mature soils, such as those of the Pullman, Olton, and Amarillo series, show marked differences in horizons. Most of the mature soils in this county are well drained and gently sloping, and they have been in place a long time.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First, through classification, and then through use of soil maps, we can apply our knowledge to specific fields and other tracts of land.

Thus, in classification soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in new developments should search the latest literature available (*6*, *8*).

New soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until review of the series concept at National, State, and regional levels of responsibility for soil classification results in a judgment that the new series should be established. Most of the soil series described in this publication have been established earlier, but two of the soil series in this survey had tentative status when the survey was sent to the printer. They are the Acuff and Berda series.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 5, the soil series of Randall County are placed in some categories of the current system. Most of the classes of the current system are briefly defined in the following paragraphs.

TABLE 5.—*Classification of soil series*

Series	Current classification		
	Family	Subgroup	Order
Acuff	Fine-loamy, mixed, thermic	Typic Argiustolls	Mollisols.
Amarillo	Fine-loamy, mixed, therimc	Typic Haplustalfs	Alfisols.
Berda	Fine-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Drake	Fine, carbonatic, thermic	Ustic Torriorthents	Entisols.
Kimbrough	Loamy, mixed, thermic, shallow	Petrocalcic Calciustolls	Mollisols.
Lea	Fine-loamy, mixed, thermic	Petrocalcic Paleustolls	Mollisols.
Lofton	Fine, montmorillonitic, thermic	Vertic Argiustolls	Mollisols.
Mansker	Fine, carbonatic, thermic	Typic Calciustolls	Mollisols.
Mobeetie	Coarse-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Olton	Fine, mixed, thermic	Typic Argiustolls	Mollisols.
Potter	Fine, carbonatic, thermic, shallow	Ustollic Calciorthids	Aridisols.
Pullman	Fine, mixed, thermic	Vertic Paleustolls	Mollisols.
Quinlan	Loamy, mixed, thermic, shallow	Typic Ustochrepts	Inceptisols.
Randall	Fine, montmorillonitic, thermic	Udic Pellusterts	Vertisols.
Roscoe	Fine, montmorillonitic, thermic	Chromic Pellusterts	Vertisols.
Spur	Fine-loamy, mixed, thermic	Fluventic Haplustolls	Mollisols.
Ulysses	Fine-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Woodward	Coarse-silty, mixed, thermic	Typic Ustrochrepts	Inceptisols.
Zita	Fine-loamy, mixed, thermic	Typic Haplustolls	Mollisols.

ORDER: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates.

The six orders represented in this county are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, and Alfisols. They are briefly defined in the following paragraphs.

Entisols are young mineral soils that do not have genetic horizons or have only the beginning of such horizons.

Vertisols are soils in which natural churning or inversion of soil material takes place, mainly through the swelling and shrinking of clays.

Inceptisols are mineral soils in which horizons have definitely started to form. They generally occur on young, but not recent, land surfaces.

Aridisols are primarily soils of dry places. They have a light-colored surface soil, and some have a clay-enriched B horizon high in base saturation. Others have free carbonates throughout their profile.

Mollisols are dark-colored soils that have a moderate to high content of organic matter and high base saturation. Some have a clay-enriched B horizon, and others have free carbonates throughout their profile.

Alfisols are soils containing a clay-enriched B horizon that has high base saturation.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of those characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. Soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUP: Suborders are separated into great groups on basis of uniformity in kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, potassium), and the like. The great group is not shown separately in table 5, because it is the last word in the name of the subgroup.

SUBGROUP: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and the others, called intergrades, that have properties of one great group and also one or more properties of another great group, subgroup, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group.

FAMILY: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, thickness of horizons, and consistence.

Chemical and Mineralogical Characteristics of the Soils

Because detailed laboratory data for soils of Randall County are lacking, the discussion of soil chemistry and mineralogy that follows is based mainly on analyses of similar soils made during study of soils on the Southwestern Great Plains Field Station (*2*, *9*) and analyses in the published soil surveys of Hansford County, Tex., and Curry County, N. Mex.

Organic matter.—The content of organic matter in soils in undisturbed areas ranges generally from 2.5 to 3 percent. In some soils on bottom lands, such as the Spur, the average content is a little higher. Analyses have shown 2.58

percent organic matter in the topmost 5 inches of Pullman clay loam and 2.9 percent in the surface layer of Mansker clay loam and Roscoe clay, though these amounts decrease rapidly as depth increases (*9*). In Pullman clay loam the content of organic matter averages only about 1 percent at a depth of 12 inches and gradually decreases to about 0.5 percent at a depth of 36 inches. In the Mansker and Ulysses soils, the average content at a depth of 12 inches is about 1 percent, but it is 0.5 percent in the Cca horizons at a depth of 24 inches or less.

After the native sod is broken, organic matter is lost fairly rapidly during the first few years that the soils are cultivated. Thereafter the loss is much slower (*2*). In most cultivated soils the plow layer is 1.5 to 2.0 percent organic matter, a loss of roughly 1 percent from their original level.

Potassium.—Apparently, enough potassium is in the soils to supply needs of crops under both irrigated and dryland methods of farming. Data on Pullman clay loam show 400 to 550 parts per million of extractable potassium (normal neutral ammonium acetate) to a depth of 4 feet (*9*).

Phosphorus.—Data on Pullman clay loam in native vegetation show 47 parts per million of phosphorus (soluble sodium bicarbonate) per acre in the top 5 inches. Of significance, however, is the sharp drop in the underlying 5- to 8-inch layer. This drop is to 9 parts per million. The average phosphorus level is about 5 parts per million at a depth of 12 inches (*9*).

The phosphorus level of the soils in this county is probably adequate for both dryland and irrigated crops. The surface layer furnishes most of the phosphorus needed. Little or no response is received by applying phosphates, except on Pullman soils, from which the surface layer has been removed and the phosphate-deficient subsoil is exposed.

Reaction.—The soils in this county range from slightly acid to moderately alkaline. The pH ranges from about 6.3 to about 8.2 in the surface horizon. Some of the soils are slightly acid or neutral to mildly alkaline in the surface horizons, but they generally increase in alkalinity with depth. Typical of these are the Pullman and Olton soils that have been leached of free lime in their upper horizons. Many soils, however, may have free lime to their surface and are moderately alkaline throughout their profile. Among these soils are Ulysses, Mansker, and Drake. In some areas along the Tierra Blanca Creek, Spur soils show evidence of strong alkalinity by the presence of slick spots and a dense cover of alkali sacaton.

Bases.—The calcium cation makes up about 75 percent of the total bases in the soils. The rest, listed in the order of decreasing amounts, are magnesium, potassium, and sodium.

The upper horizon of the soils in this county is generally free of sodium, but there are minor amounts in the subsoil and substratum of most soils. In Pullman and Mansker soils, exchangeable sodium typically ranges between 1 and 3 percent but is 10 percent in a few places (*9*).

The cation-exchange capacity of the major soils ranges from 12 to about 28 milliequivalents per 100 grams of soil. For example the cation-exchange capacity of the surface layer of a cultivated Pullman clay loam that is about 2 percent organic matter ranges between 18 and 21 milliequivalents per 100 grams of soil. The subsoil of Pullman clay loam, which is clay, is low in organic-matter content and has a cation-exchange capacity ranging from 24 to 30 milliequivalents per 100 grams of soil. The Cca horizon of Ulysses and Mansker soils has a cation-exchange capacity of 12 to 15 milliequivalents per 100 grams of soil.

Base saturation ranges from about 70 percent in the upper horizons of Pullman and Olton soils to nearly 100 percent in soil horizons having free lime (*9*).

Clays.—The clay fraction (less than 2 microns in diameter) of the soils are of two kinds: (1) chemically active alumino-silicates and (2) inert carbonates. The alumino-silicate clays have a moderately high shrink-swell coefficient and moderate to high cation-exchange capacity. The principal types of clay are montmorillonite and illite, and they make up most of the clay fraction in the solum of Pullman soils (*9*). The rest is largely the kaolinite type. Analyses of the cation-exchange capacity of clays from the various horizons of Pullman soils show a range of 73 to 93 milliequivalents per 100 grams of soil. Silica-sesquioxide ratios of these clays were dominantly between 3 and 4, but the range is from about 2.0 to 4.5.

Clay-sized carbonates are mostly in the strongly calcareous horizons, such as the B2ca horizon of Mansker soils and the Cca horizon of Pullman and Olton soils. Unpublished data of the Soil Conservation Service from a profile of Mansker clay loam in Carson County, Texas, show clay-sized carbonates in all horizons. The largest amount, 18 percent, was in the Cca horizon.

Additional Facts About the County

This section was prepared for those who want general information about Randall County. It briefly discusses the settlement, early development, and population; the climate; and the agriculture of the county.

Settlement, Early Development, and Population

The area that is now Randall County was originally inhabited by various tribes of Plains Indians, who hunted and camped in this area. Herds of buffalo roamed the area, but they were slaughtered in the 1860's and 1870's by hunters. By 1875 few were left. In 1876 the first cattle ranch in the area was established in Palo Duro Canyon. This ranch eventually occupied 650,000 acres.

At first the scarcity of water limited the number of ranches in the county, but many small ranches were established on the High Plains after windmills and barbed wire came into use. The first successful water well was drilled on the High Plains in 1885. Later, settlers from the Middle West planted small grains.

Randall County was named for Gen. Horace Randall, a Confederate soldier. The county was created from Bexar Territory in 1876 and was organized in 1889. The total population of the county was 13,774 in 1950, and this increased to 33,913 in 1960. The population of Canyon, the county seat, increased from 4,364 in 1950 to 5,864 in 1960. In 1963, Canyon had a population of 6,265.

Climate [5]

The climate of Randall County is cool temperate. Rainfall occurs most frequently in thunderstorms rather than

[5] By Robert B. Orton, State climatologist, U.S. Weather Bureau.

TABLE 6.—*Temperature and precipitation*

[Elevation

Month	Temperature											
	Average			Degree days	Extremes				Average number of days when maximum temperature is—		Average number of days when minimum temperature is—	
	Daily maximum	Daily minimum	Monthly		Highest recorded		Lowest recorded		90° or above	32° or below	32° or below	0° or below
	° F.	° F.	° F.		° F.	Year	° F.	Year	° F.	° F.	° F.	° F.
January	54.2	22.4	38.3	859	79	1956	−12	1959	0	2	28	1
February	58.8	26.9	42.9	628	86	1962	−14	1951	0	2	20	(3)
March	64.9	31.3	48.1	526	89	1963	0	1960	0	(3)	18	(3)
April	73.9	41.4	57.7	229	93	1959	20	1952	1	0	4	0
May	81.9	51.5	66.7	55	99	1953	27	1954	7	0	(3)	0
June	90.1	60.6	75.4	6	107	1953	42	1955	17	0	0	0
July	91.3	64.1	77.7	(3)	103	1953	52	[4] 1954	23	0	0	0
August	91.1	63.2	77.2	(3)	103	1953	50	[4] 1962	21	0	0	0
September	85.2	56.5	70.9	19	100	1953	39	[4] 1959	9	0	0	0
October	76.1	44.8	60.5	173	96	1954	25	[4] 1955	1	0	2	0
November	62.5	30.6	46.6	538	90	1952	3	[4] 1957	0	0	17	0
December	55.6	25.1	40.4	748	82	1955	−1	1954	0	1	25	(3)
Year	73.8	43.2	58.5	3,781	107	1953	−14	1951	79	5	114	1

[1] Temperature records are for 1950–63. Average number days when precipitation is 0.10 inch or more is for a 10-year period. Extremes in precipitation, average monthly precipitation, and snow and sleet data are for a 28-year period.
[2] One year in 10 will have no rainfall in this month.

in general rains. This kind of rainfall is spotty and partly accounts for the extreme variability in precipitation. Rainfall is greatest during May, June, and July, and three-fourths of the average annual rain falls during the 6-month period, May through October. Dry spells of several weeks or more are common, and there are monthly periods without measurable rain. These periods have occurred in all months except April, May, July, and August. Table 6 is a summary of the climate at Canyon for the period 1934–63.

During winter frequent cold fronts block the moisture from the Gulf of Mexico, and precipitation is limited. Precipitation in winter usually falls as rain or snow, but sometimes the rain and snow are mixed. Snowfalls are generally light, and the snow remains on the ground for only a short time. Heavy snow does fall infrequently when moisture from the gulf is carried into low pressure centers over the Texas Panhandle. Because much of the snow is driven by the wind into high drifts, distribution of moisture is uneven when the snow melts.

Like rainfall, temperature in Randall County is extremely variable, especially from November through April. Cold fronts from the northern part of the Rocky Mountains and the Plains States sweep across the plains of the Panhandle at speeds of 20 to 40 miles per hour. Temperature commonly drops 50 to 60 degrees within 12 hours. Cold spells seldom last more than 2 or 3 days before southwesterly winds from the high plateaus in New Mexico cause rapid warming. Also, temperature falls a great deal from the maximum in the afternoon to the minimum early in the morning. This is because the dry air, high elevation, and usually clear skies permit warming by the sun during the day and cooling by radiation at night.

July has the highest daily maximum temperature, but the maximum temperature recorded was 107° in June 1953. The wind and low humidity prevent the high daytime temperatures from being uncomfortable. The county receives about 72 percent of the possible sunshine.

The average speed of the wind is fairly high because the surface of the county offers little resistance to the wind. The strong continuous winds that normally are most frequent in March and April cause soil blowing and duststorms. The prevailing winds are usually southerly from May through September and southwesterly during the rest of the year. Winds, in short gusts, are strongest during intense thunderstorms.

Hail may accompany almost any thunderstorm, but damaging hailstorms are fairly infrequent and cover only small areas. Hail is most frequent late in spring and early in summer.

Humidity averages about 72 percent at 6:00 a.m. and only about 38 percent at 6:00 p.m. The most cloudiness occurs in the period January through May.

The average length of the freeze-free period is 200 days, but the length of this period varies considerably from year to year. Between the last occurrence of a 28° temperature in spring and the first occurrence in fall, the average number of days is 215. April 15 is the average date of the last

at Canyon Tex., 1934–63 [1]

3,577 feet]

Precipitation											
Average monthly	Greatest daily		Driest year (1956)	Wettest year (1941)	One year in 10 will have—		Average number of days when precipitation is—			Snow, sleet		
					Less than—	More than—	0.10 inch or more	0.05 inch or more	1.00 inch or more	Monthly average	Monthly maximum	
Inches	*Inches*	*Year*	*Inches*	*Inches*	*Inches*	*Inches*				*Inches*	*Inches*	*Year*
0.58	1.77	1939	0.07	0.36	(2)	1.5	1	(3)	(3)	2.3	12.0	1946
.51	1.22	1951	1.47	.49	(2)	1.2	2	(3)	(3)	2.0	18.0	1956
.76	1.75	1934	.00	2.60	(2)	2.4	2	1	0	.9	8.0	1942
1.39	2.57	1953	.30	1.20	0.3	2.4	2	1	(3)	.4	9.5	1938
3.19	5.80	1951	3.24	6.90	.3	5.9	4	2	1	0	0	--------
2.91	3.65	1962	1.04	3.98	1.0	5.4	6	3	1	0	0	--------
2.85	3.40	1944	3.09	3.31	.7	6.1	5	2	1	0	0	--------
2.22	2.15	1945	1.54	2.27	.3	4.1	4	2	1	0	0	--------
1.75	3.11	1941	.00	5.37	(2)	3.7	2	1	(3)	0	0	--------
1.98	3.05	1946	.47	10.12	.2	5.5	3	1	(3)	.1	4.0	1941
.59	1.28	1940	.00	.44	(2)	1.3	2	(3)	0	.3	5.0	1941
.80	2.02	1943	(5)	.95	(2)	1.8	1	(3)	(3)	2.1	14.0	1939
19.53	5.80	1951	11.22	37.99	12.3	28.0	34	13	4	8.1	18.0	1956

[3] Less than one-half day.
[4] Also on earlier dates, months, or years.
[5] Trace.

32° temperature in spring. On the average, 1 year out of every 5 will have a 32° temperature after April 23. The average date of the first freeze in fall is November 1. On an average of 1 year out of every 5, a freeze will occur before October 16. Because of differences in elevation and uneven terrain, these average dates vary locally within the county.

Average annual lake evaporation is approximately 66 inches. Of this, 45 inches evaporates in the period May through October.

Agriculture

Agriculture, mainly dryland and irrigation farming, cattle ranching, and dairying, is the chief enterprise in Randall County. Cattle ranching was the first agricultural occupation, but later farming began when settlers came from the Middle West and planted small grains. This subsection discusses the major crops and livestock in the county. Statistics are from the U.S. Census of Agriculture.

Crops

Winter wheat, grain sorghum, cotton, and corn are the most important crops in the county. These crops are grown under both dryfarming and irrigation. Wheat, the major crop, is grown primarily for grain, but much of the acreage in wheat is also used for pasture. Because the acreage in wheat is controlled, sorghum is now grown in many fields that were used for wheat. Barley and oats are grown in a few areas. Since irrigation began, small acreages of cotton and field corn have been grown. The southern part of the county is the northern limit for growing cotton.

Harvested in the county in 1964 were 78,264 acres of wheat, 52,738 acres of grain sorghum, 1,940 acres of cotton, and 2,036 acres of corn.

Farm power and mechanical equipment

Farming in Randall County is becoming highly mechanized. Heavy tillage implements, such as chisels, listers, sweeps, one-way plows, and rotary rod weeders, are mostly drawn by large rubber-tired tractors that are powered by diesel, propane, or gasoline engines. Self-propelled combine harvesters have replaced tractor-drawn combines. Special implements, such as fertilizer applicators, hay and silage harvesters, weed sprayers, and ditchers, are used in irrigated areas.

Livestock

Beef cattle are the chief livestock, but some dairy cattle are raised for whole milk and butterfat sold or used locally.

Since irrigation has developed, a large number of beef cattle and all of the dairy cattle are fed with locally grown irrigated small grains, forage sorghum, and corn, mostly in the form of ensilage. The number of herds of purebred cattle has increased.

On farms and ranches in the county in 1964 were 50,675 cattle and calves, 3,961 hogs and pigs, 2,278 sheep and lambs, and 32,462 chickens.

Literature Cited

(1) American Association of State Highway Officials.
1961. STANDARD SPECIFICATION FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING. Ed. 8, 2 v., illus.

(2) Coover, James R., Van Doren, C. E., and Whitfield, Charles J.
1953. SOME CHARACTERISTICS OF THE PULLMAN SOILS ON THE AMARILLO EXPERIMENT STATION. Tex. Agr. Expt. St. Misc. Pub. 97, 11 pp., illus.

(3) Frye, John C., and Leonard, A. Byron.
1957. ECOLOGICAL INTERPRETATIONS OF PLIOCENE AND PLEISTOCENE STRATIGRAPHY IN THE GREAT PLAINS REGION. Amer. Jour. Sci. 225: 1–11, illus.

(4) ———
1957. STUDIES OF CENOZOIC GEOLOGY ALONG EASTERN MARGIN OF TEXAS HIGH PLAINS, ARMSTRONG TO HOWARD COUNTIES. Univ. Tex., Bur. Econ. Geol. Rpt. 32: 60 pp., illus.

(5) Lotspeich, F. B., and Coover, J. R.
1962. SOIL FORMING FACTORS ON THE LLANO ESTACADO: PARENT MATERIAL, TIME, AND TOPOGRAPHY. Tex. Jour. of Sci., v. XIV, No. 1, pp. 7–17, illus.

(6) Simonson, Roy W.
1962. SOIL CLASSIFICATION IN THE UNITED STATES. Sci. 137: 1027–1034.

(7) United States Department of Agriculture.
1951. SOIL SURVEY MANUAL. U.S. Dept. Agr. Handbook 18, 503 pp., illus.

(8) ———
1960. SOIL CLASSIFICATION, A COMPREHENSIVE SYSTEM, 7TH APPROXIMATION. 265 pp., illus. [Supplement issued in March 1967]

(9) Taylor, Howard M., Van Doren, C. E., Godfrey, Curtis L., and Coover, James R.
1963. SOILS OF THE SOUTHWESTERN GREAT PLAINS FIELD STATION. Misc. Pub. 669, 14 pp., illus.

(10) Waterways Experiment Station, Corps of Engineers.
1953. THE UNIFIED SOIL CLASSIFICATION SYSTEM. Tech. Memo. 3-357, 2 v. and appendix.

Glossary

Aggregate, soil. Many fine particles of soil held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alkaline soil. Generally, a soil that is alkaline throughout most or all of the part occupied by plant roots. Precisely, any soil having a pH value greater than 7.0; practically, a soil having a pH above 7.3

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited on land by streams.

Bench terrace. A shelflike embankment of earth that has a level or nearly level top and a steep or vertical downhill face, constructed along the contour of sloping land or across the slope to control runoff and erosion. The downhill face of the bench may be made of rocks or masonry, or it may be planted to vegetation.

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Chlorosis. A yellowing between veins on upper foliage that results from chlorophyll deficiency. Many factors, including heredity, cause chlorosis.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: Clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose. Noncoherent; will not hold together in a mass.

Friable. When moist, crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm. When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, readily deformed by moderate pressure but can be pressed into a lump; forms a wire when rolled between thumb and forefinger.

Sticky. When wet, adheres to other material; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard. When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft. When dry, breaks into powder or individual grains under very slight pressure.

Cemented. Hard and brittle; little affected by moistening.

Eolian soil material. Soil parent material accumulated through wind action; commonly refers to sand material in dunes.

Granule. A single mass, or cluster, of many individual soil particles.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons.

O horizon. The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon. The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and it is therefore marked by accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon. The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has (1) distinctive characteristics caused by accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon; or (4) some combination of these. The combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon. The weathered rock material immediately beneath the solum. This layer, commonly called the soil parent material, is presumed to be like that from which the overlying horizons were formed in most soils. If the underlying material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer. Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath the A or B horizon.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the height of the water table, either permanent or perched. Relative terms for expressing internal drainage are *none, very slow, slow, medium, rapid,* and *very rapid.*

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles.

Ped. An individual natural soil aggregate, such as a crumb, a prism or a block, in contrast to a clod.

Reaction, soil. The degree of acidity or alkalinity of a soil expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. In words the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Red beds. Red to reddish-brown material of the Triassic and Permian formations.

Saline soil. A soil that contains soluble salts in amounts detrimental to plants but does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slope. A vertical rise or fall of the land surface in feet per 100 feet of horizontal distance. In this county slope classes by names refer to specific ranges in percent as follows:

Class name	*Range in percent*
Nearly level	Less than 1
Gently sloping	1 to 3
Moderately sloping	3 to 5
Sloping	5 to 8
Strongly sloping	8 to 12
Moderately steep	12 to 20
Steep	20 and over

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying parent material.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, either conforming (C or R) or unconforming.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness; the plowed layer.

Tail water. The water just downstream from a structure.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts runoff so that it may soak into the soil or flow slowly to a prepared outlet. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of fine particles are as follows: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the soil series to which the mapping unit belongs. Other information is given in tables as follows:

Acreage and extent, table 1, p. 7.
Predicted yields, table 2, p. 39.

Engineering uses of the soils, tables 3 and 4, pp. 46 through 51.

Map symbol	Mapping unit	Described on page	Dryland capability unit Symbol	Dryland capability unit Page	Irrigated capability unit Symbol	Irrigated capability unit Page	Range site Name	Range site Page
AcA	Acuff loam, 0 to 1 percent slopes------	8	IIIce-2	35	I-2	33	Deep Hardland	40
AcB	Acuff loam, 1 to 3 percent slopes------	9	IIIe-2	34	IIe-1	33	Deep Hardland	40
AmA	Amarillo fine sandy loam, 0 to 1 percent slopes-----------------------	10	IIIe-4	35	--------	--	Sandy Loam	41
AmB	Amarillo fine sandy loam, 1 to 3 percent slopes-----------------------	10	IIIe-4	35	--------	--	Sandy Loam	41
AmC	Amarillo fine sandy loam, 3 to 5 percent slopes-----------------------	10	IVe-4	36	--------	--	Sandy Loam	41
BeB	Berda loam, 1 to 3 percent slopes------	11	IIIe-3	35	IIIe-4	35	Hardland Slopes	42
BeC	Berda loam, 3 to 5 percent slopes------	11	IVe-2	36	IIIe-2	35	Hardland Slopes	42
BeD	Berda loam, 5 to 12 percent slopes-----	12	VIe-1	37	--------	--	Hardland Slopes	42
Br	Broken alluvial land-------------------	12	Vw-1	37	--------	--	Loamy Bottomland	40
DrB	Drake soils, 1 to 3 percent slopes-----	13	IVes-1	36	IIIes-1	36	High Lime	42
DrD	Drake soils, 3 to 8 percent slopes-----	13	VIe-3	37	--------	--	High Lime	42
Ke	Kimbrough-Lea loams--------------------	14	VIIs-1	38	--------	--	Very Shallow	44
Lo	Lofton clay loam-----------------------	15	IIIce-1	35	IIs-1	34	Deep Hardland	40
MkA	Mansker clay loam, 0 to 1 percent slopes------------------------------	16	IVe-9	37	IIIe-10	35	Hardland Slopes	42
MkB	Mansker clay loam, 1 to 3 percent slopes------------------------------	17	IVe-9	37	IIIe-10	35	Hardland Slopes	42
MkC	Mansker clay loam, 3 to 5 percent slopes------------------------------	17	IVe-2	36	IVe-6	37	Hardland Slopes	42
MkC2	Mansker clay loam, 3 to 5 percent slopes, eroded----------------------	17	VIe-1	37	--------	--	Hardland Slopes	42
MkD	Mansker clay loam, 5 to 8 percent slopes------------------------------	18	VIe-1	37	--------	--	Hardland Slopes	42
MrC	Mobeetie fine sandy loam, 3 to 5 percent slopes----------------------	18	IVe-5	37	--------	--	Mixedland Slopes	41
MrD	Mobeetie fine sandy loam, 5 to 12 percent slopes----------------------	18	VIe-2	37	--------	--	Mixedland Slopes	41
OcA	Olton clay loam, 0 to 1 percent slopes-	19	IIIce-2	35	I-1	33	Deep Hardland	40
OcB	Olton clay loam, 1 to 3 percent slopes-	20	IIIe-2	34	IIe-2	34	Deep Hardland	40
OcC	Olton clay loam, 3 to 5 percent slopes-	20	IVe-1	36	IIIe-2	35	Deep Hardland	40
Pe	Potter soils---------------------------	21	VIIs-1	38	--------	--	Very Shallow	44
PmA	Pullman clay loam, 0 to 1 percent slopes------------------------------	22	IIIce-1	35	IIs-1	34	Deep Hardland	40
PmB	Pullman clay loam, 1 to 3 percent slopes------------------------------	23	IIIe-1	34	IIIe-1	34	Deep Hardland	40
PmB2	Pullman clay loam, 1 to 3 percent slopes, eroded----------------------	23	IVe-3	36	IIIe-2	35	Deep Hardland	40
PuA	Pullman clay loam, moderately shallow, 0 to 1 percent slopes----------------	24	IIIce-1	35	IIs-1	34	Deep Hardland	40
PuB	Pullman clay loam, moderately shallow, 1 to 3 percent slopes----------------	24	IIIe-1	34	IIIe-1	34	Deep Hardland	40
Qw	Quinlan-Woodward complex---------------	25	VIe-4	37	--------	--	Mixedland	44
Ra	Randall clay---------------------------	25	VIw-1	37	--------	--	----------------	--
Rc	Roscoe clay----------------------------	27	IIIce-1	35	IIs-1	34	Deep Hardland	40
Ro	Rough broken land----------------------	27	VIIs-2	38	--------	--	Rough Breaks	43
Sb	Spur clay loam, broken-----------------	28	Vw-1	37	--------	--	Loamy Bottomland	40
Sc	Spur clay loam-------------------------	28	IIe-1	33	I-2	33	Loamy Bottomland	40
UcA	Ulysses clay loam, 0 to 1 percent slopes------------------------------	29	IIIce-3	36	IIe-3	34	Hardland Slopes	42
UcB	Ulysses clay loam, 1 to 3 percent slopes------------------------------	30	IIIe-3	35	IIIe-4	35	Hardland Slopes	42
ZcA	Zita clay loam, 0 to 1 percent slopes--	31	IIIce-2	35	I-2	33	Deep Hardland	40
ZcB	Zita clay loam, 1 to 3 percent slopes--	31	IIIe-2	34	IIe-1	33	Deep Hardland	40

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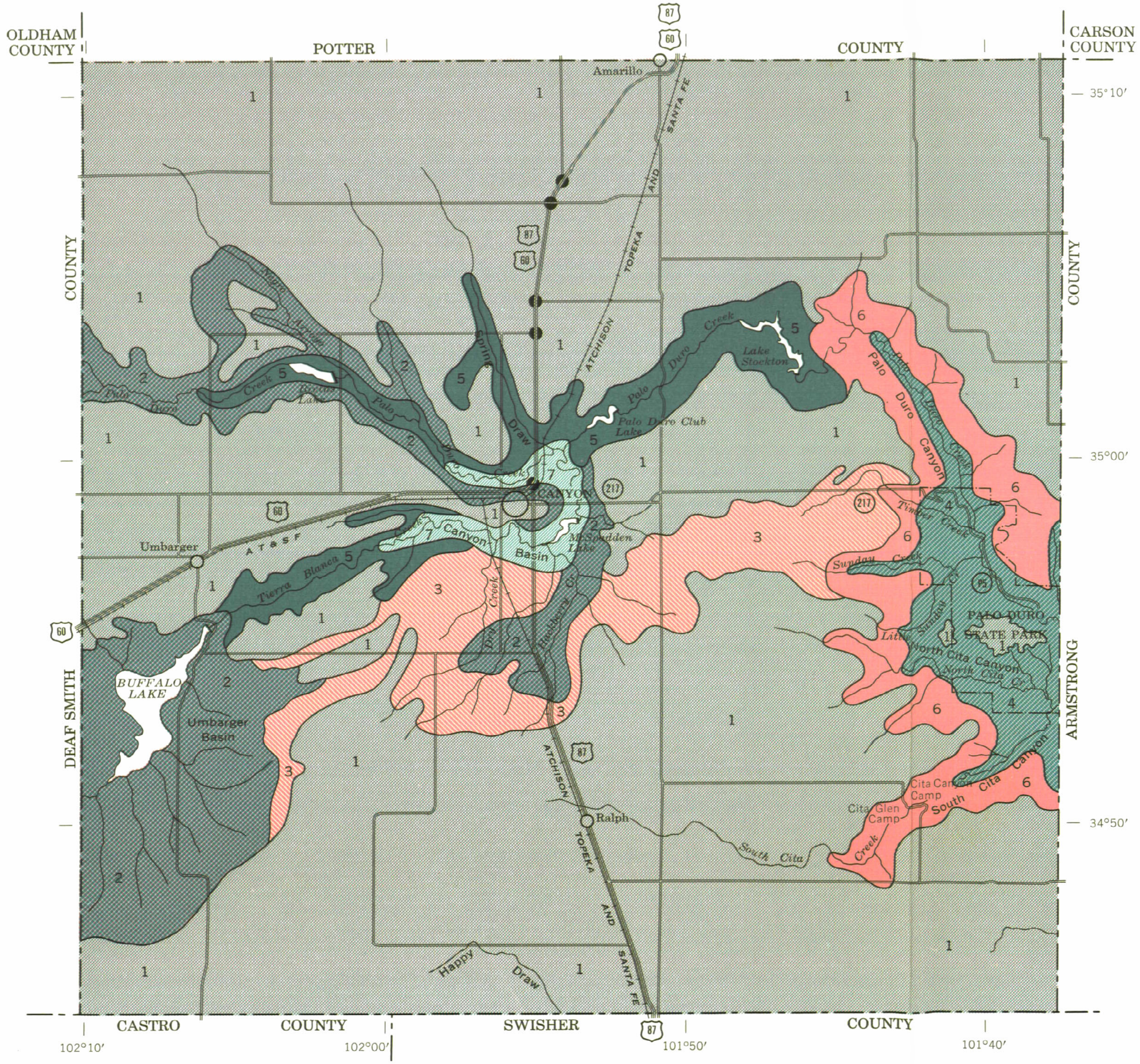
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
RANDALL COUNTY, TEXAS

SCALE IN MILES
1 0 1 2 3 4



NOTE— This map is intended for general planning. Each delineation may contain soils having ratings different from those shown on the map. Use detailed soil maps for operational planning.

SOIL ASSOCIATIONS

1 Pullman association: Nearly level to gently sloping, deep soils that have a loamy surface layer and a firm clay subsoil

2 Ulysses–Mansker association: Nearly level to moderately sloping, loamy soils that are shallow and moderately deep over caliche

3 Olton–Amarillo association: Nearly level to moderately sloping, deep soils that have a loamy surface layer and subsoil

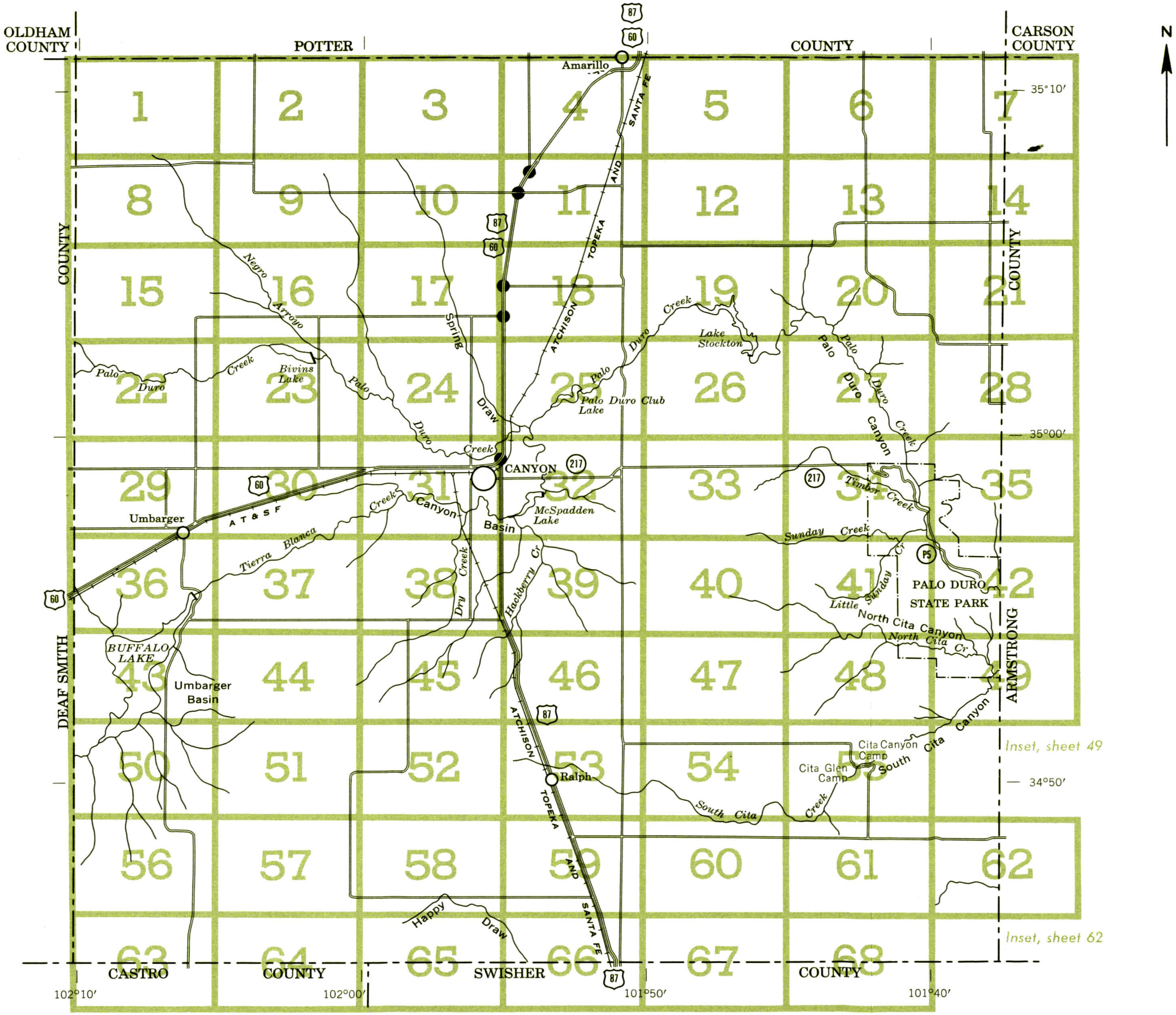
4 Rough broken land–Potter–Quinlan–Woodward association: Rough broken land and dissected, loamy soils that are very shallow to moderately deep over caliche, sandstone, or siltstone

5 Mansker–Berda–Potter association: Gently sloping to sloping, deep, loamy soils on foot slopes, and sloping to steep, loamy soils that are very shallow to moderately deep over caliche

6 Potter–Mobeetie association: Moderately sloping to steep, loamy soils on escarpments and foot slopes

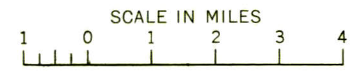
7 Spur–Berda association: Nearly level to gently sloping, deep, loamy soils on flood plains and foot slopes

August 1968



INDEX TO MAP SHEETS

RANDALL COUNTY, TEXAS



CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferry — FY
- Ford — FORD
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mines and Quarries

Mine dump

Pits, gravel or caliche

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Windmill

BOUNDARIES

- National or state
- County
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches — CANAL

Lakes and ponds
- Perennial — water, w
- Intermittent

Buffalo Lake flood pool line

Spring

Marsh or swamp

Wet spot

Alluvial fan

Drainage end

Irrigation well, water — I.W.

City well, water — C.W.

RELIEF

Prominent peak

Depressions and sinkholes — Large, Small
- Unclassified

SOIL SURVEY DATA

- Soil boundary and symbol — Dx
- Gravel
- Stony, very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, or D, shows the slope. Most symbols without a slope letter are those of nearly level soils or land types but some are for soils or land types that have a considerable range of slope. A final number, 2, in the symbol means that a soil is eroded. (W) following the soil name indicates that signs of erosion, especially of local shifting of soil by wind, are evident in places, but the degree of erosion cannot be estimated reliably.

SYMBOL	NAME
AcA	Acuff loam, 0 to 1 percent slopes
AcB	Acuff loam, 1 to 3 percent slopes
AmA	Amarillo fine sandy loam, 0 to 1 percent slopes (W)
AmB	Amarillo fine sandy loam, 1 to 3 percent slopes (W)
AmC	Amarillo fine sandy loam, 3 to 5 percent slopes (W)
BeB	Berda loam, 1 to 3 percent slopes
BeC	Berda loam, 3 to 5 percent slopes
BeD	Berda loam, 5 to 12 percent slopes
Br	Broken alluvial land
DrB	Drake soils, 1 to 3 percent slopes (W)
DrD	Drake soils, 3 to 8 percent slopes (W)
Ke	Kimbrough–Lea loams
Lo	Lofton clay loam
MkA	Mansker clay loam, 0 to 1 percent slopes
MkB	Mansker clay loam, 1 to 3 percent slopes
MkC	Mansker clay loam, 3 to 5 percent slopes
MkC2	Mansker clay loam, 3 to 5 percent slopes, eroded
MkD	Mansker clay loam, 5 to 8 percent slopes
MrC	Mobeetie fine sandy loam, 3 to 5 percent slopes (W)
MrD	Mobeetie fine sandy loam, 5 to 12 percent slopes (W)
OcA	Olton clay loam, 0 to 1 percent slopes
OcB	Olton clay loam, 1 to 3 percent slopes
OcC	Olton clay loam, 3 to 5 percent slopes
Pe	Potter soils
PmA	Pullman clay loam, 0 to 1 percent slopes
PmB	Pullman clay loam, 1 to 3 percent slopes
PmB2	Pullman clay loam, 1 to 3 percent slopes, eroded
PuA	Pullman clay loam, moderately shallow, 0 to 1 percent slopes
PuB	Pullman clay loam, moderately shallow, 1 to 3 percent slopes
Qw	Quinlan–Woodward complex
Ra	Randall clay
Rc	Roscoe clay
Ro	Rough broken land
Sb	Spur clay loam, broken
Sc	Spur clay loam
UcA	Ulysses clay loam, 0 to 1 percent slopes
UcB	Ulysses clay loam, 1 to 3 percent slopes
ZcA	Zita clay loam, 0 to 1 percent slopes
ZcB	Zita clay loam, 1 to 3 percent slopes

Soil map constructed 1967 by Cartographic Division, Soil Conservation Service, USDA, from 1959 aerial photographs. Controlled mosaic based on Texas plane coordinate system, north zone, Lambert conformal conic projection, 1927 North American datum.

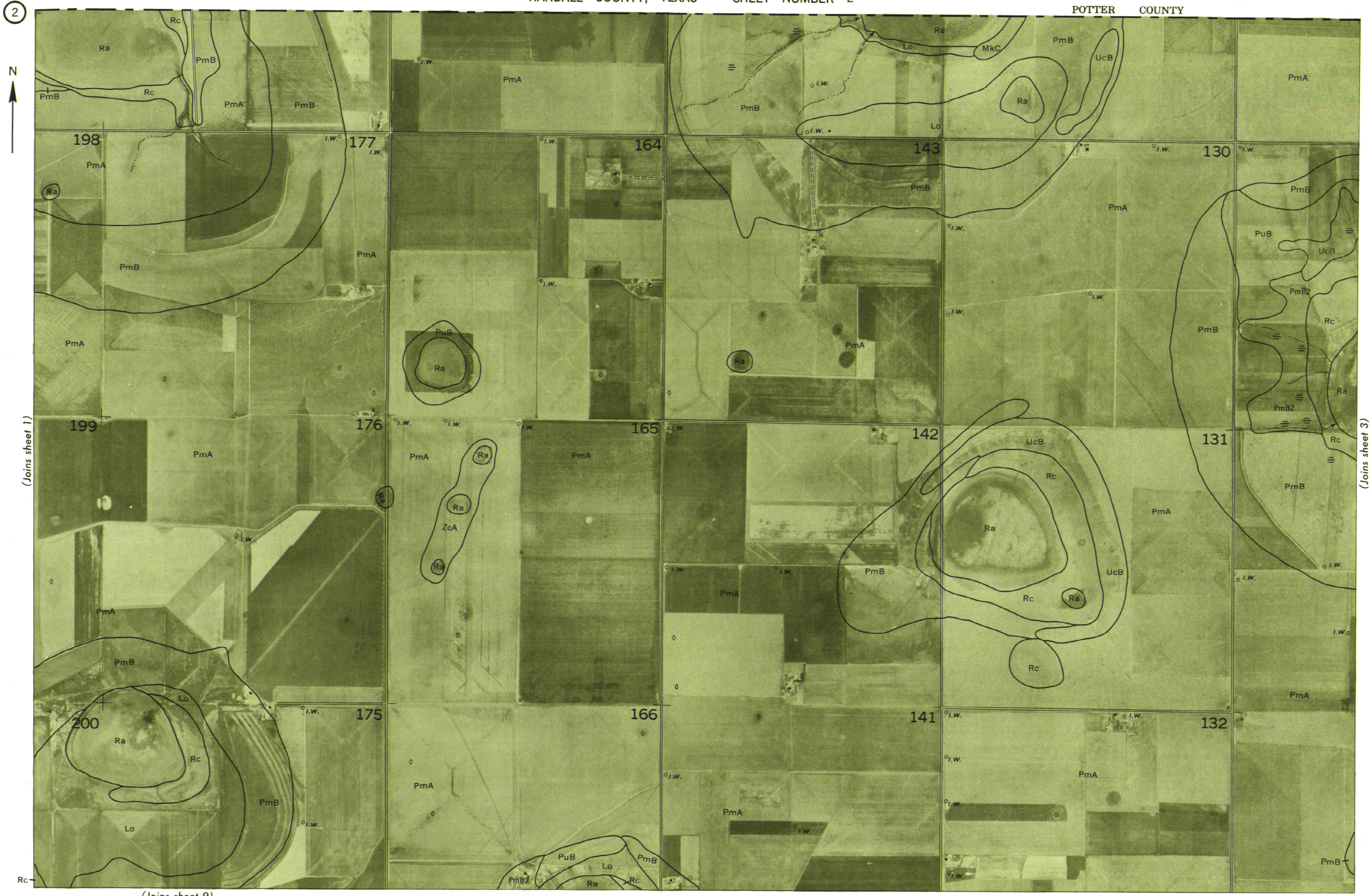
RANDALL COUNTY, TEXAS — SHEET NUMBER 1

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 1

RANDALL COUNTY, TEXAS — SHEET NUMBER 2



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 2

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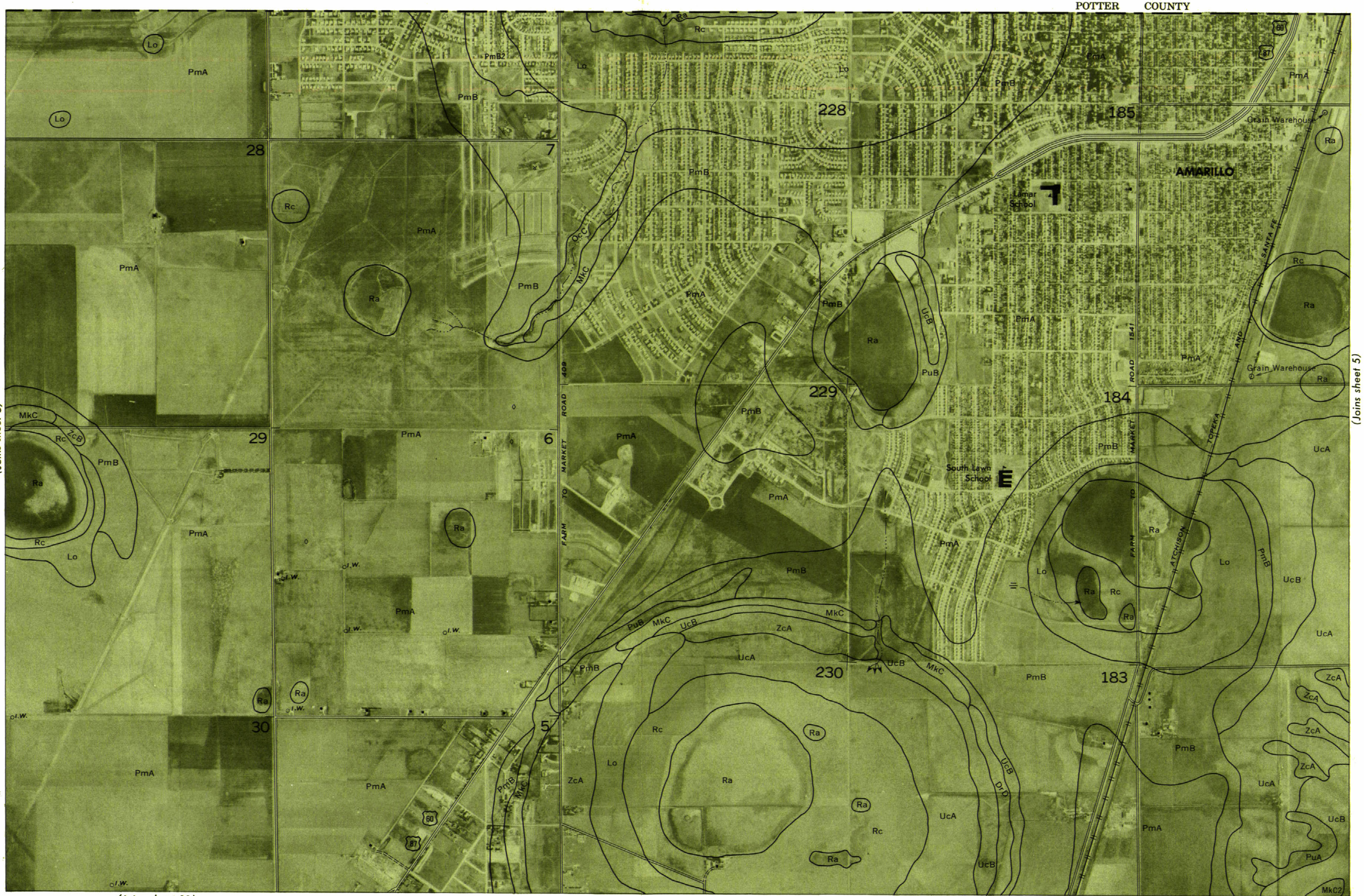
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 3

RANDALL COUNTY, TEXAS — SHEET NUMBER 4

N



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(Joins sheet 11)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

RANDALL COUNTY, TEXAS NO. 4

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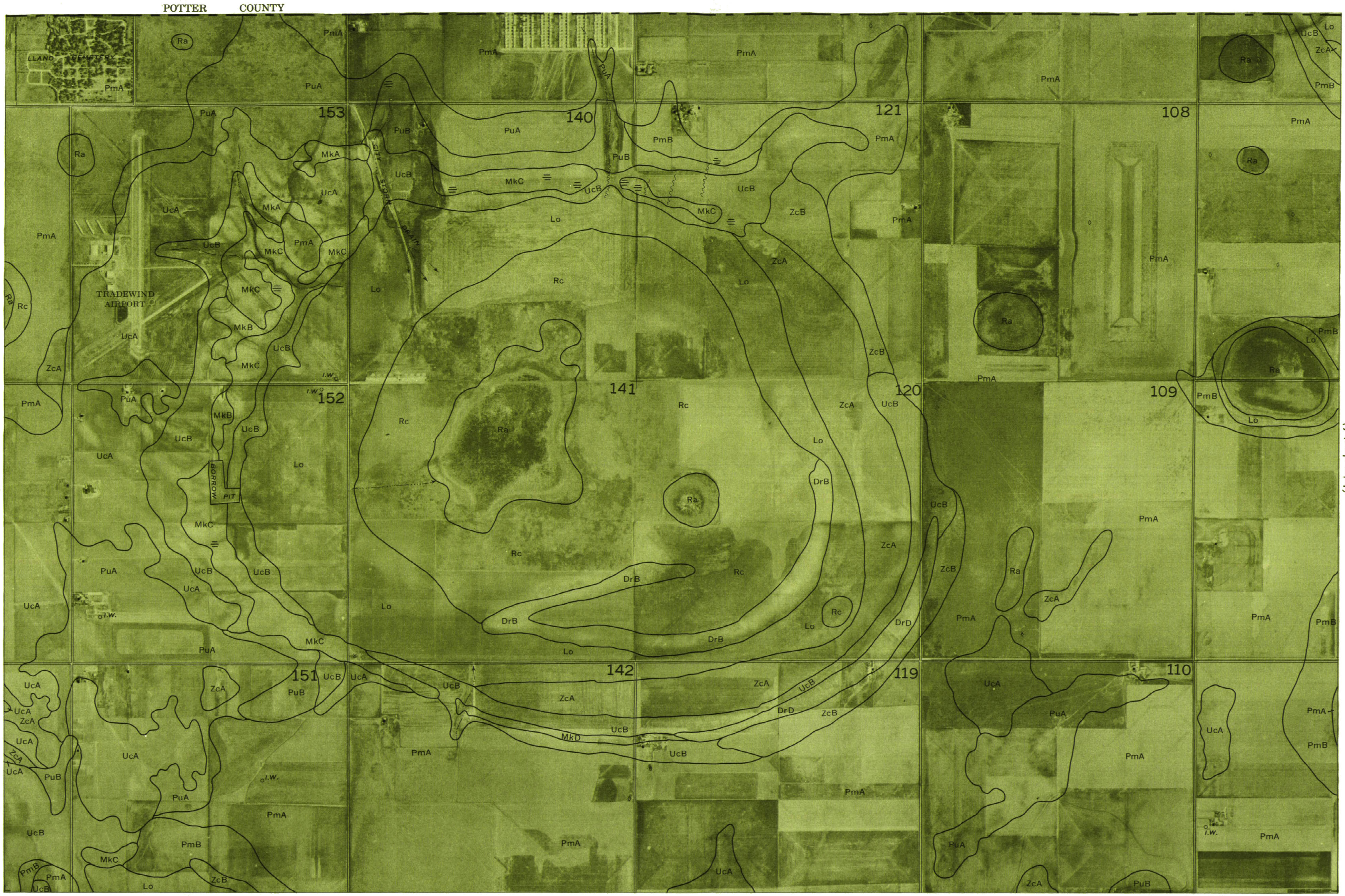
RANDALL COUNTY, TEXAS — SHEET NUMBER 5

5



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0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 5

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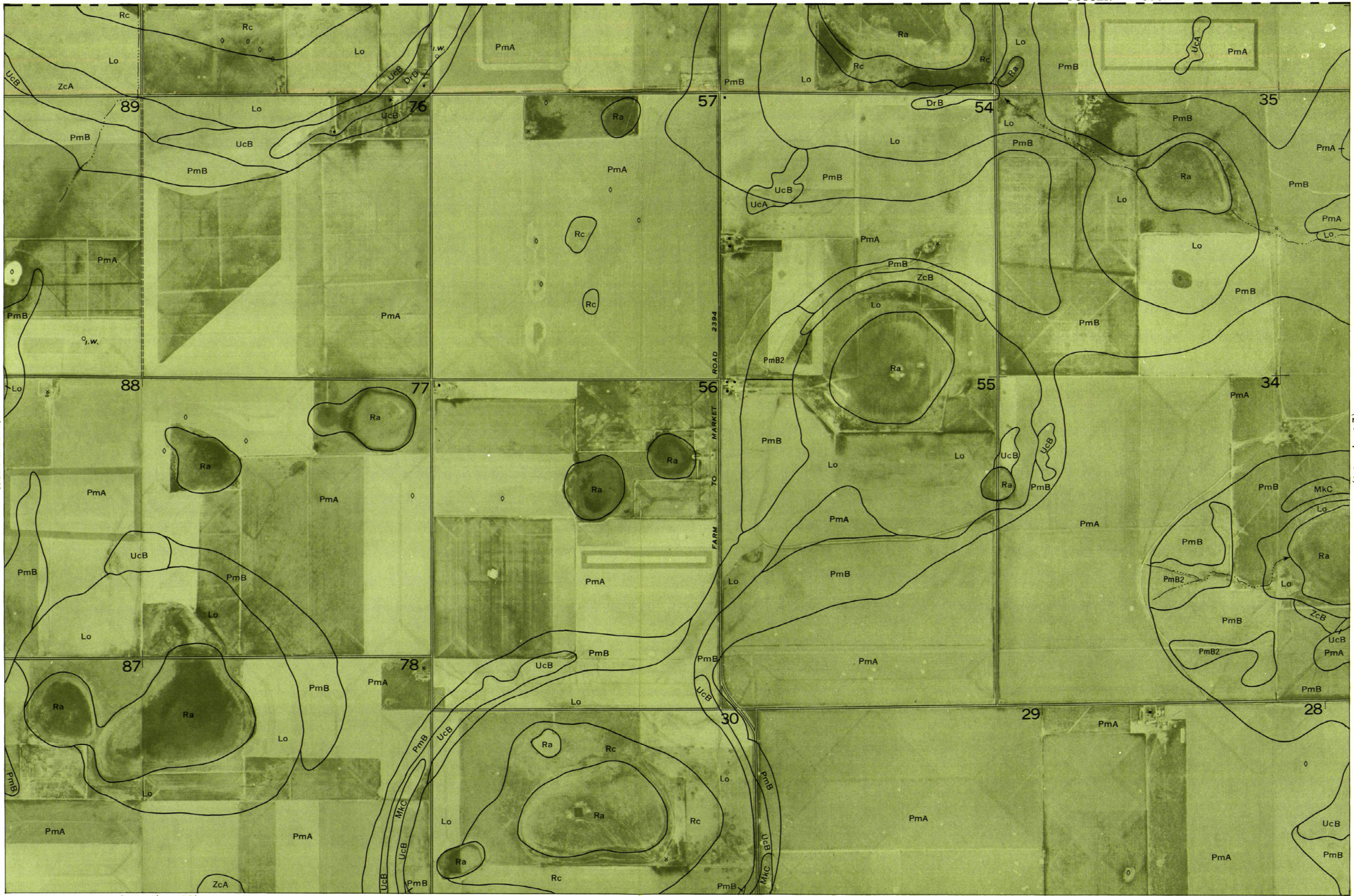
RANDALL COUNTY, TEXAS — SHEET NUMBER 6



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0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 6

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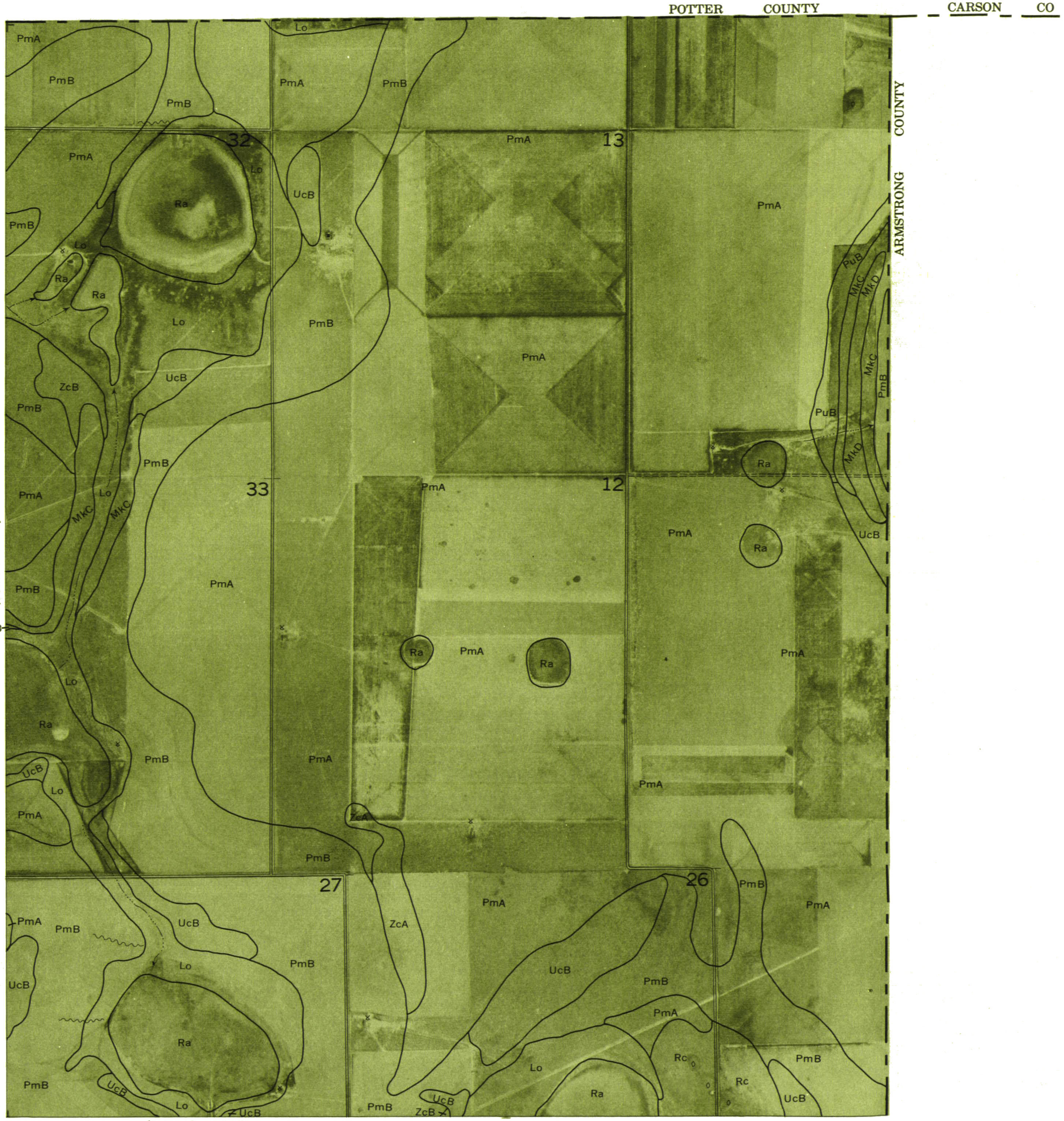

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RANDALL COUNTY, TEXAS NO. 7
Scale 1: 20 000

1 Mile ½ 0
5000 Feet 0

RANDALL COUNTY, TEXAS — SHEET NUMBER 8

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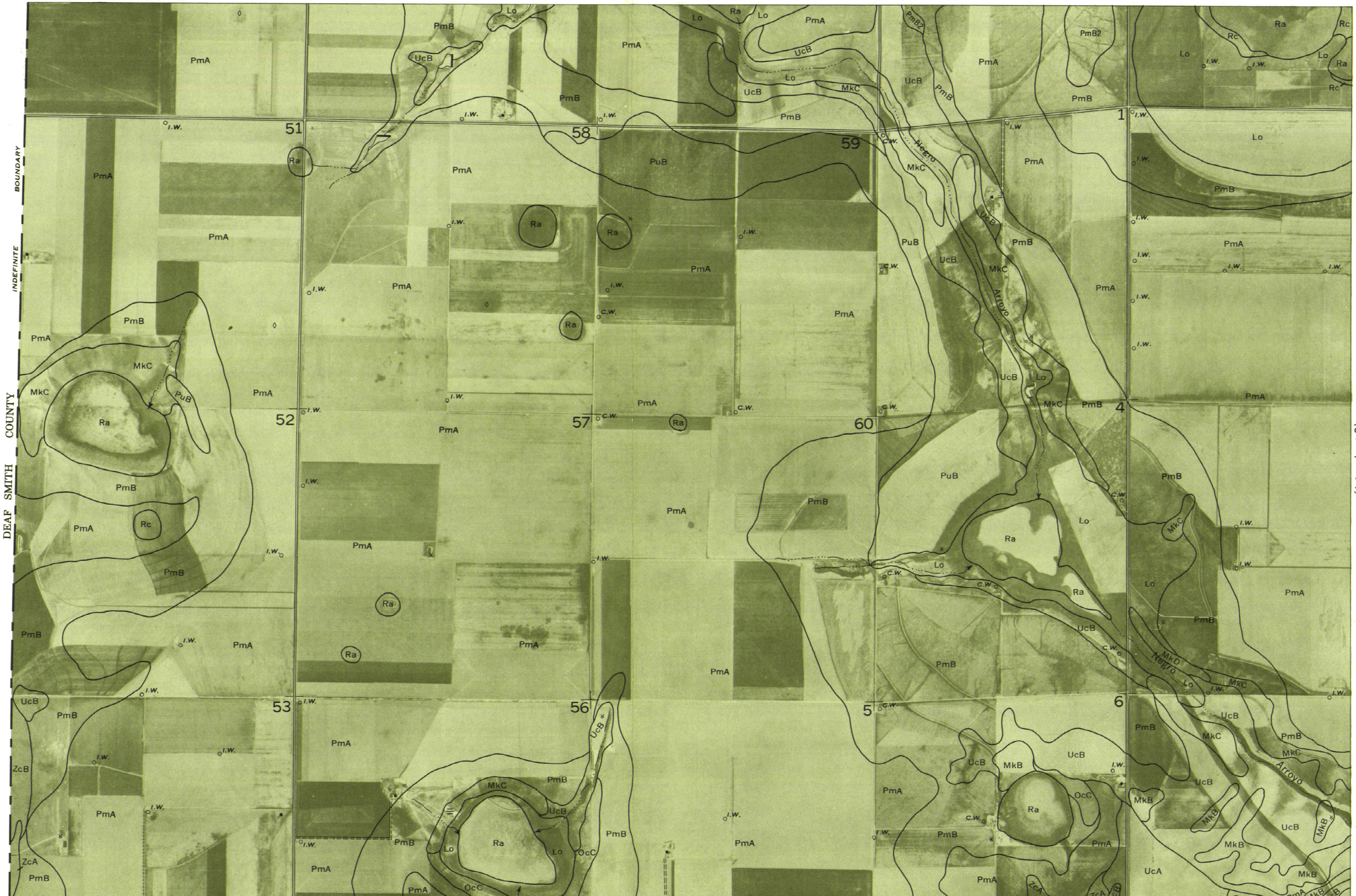

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0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

RANDALL COUNTY, TEXAS NO. 8

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RANDALL COUNTY, TEXAS — SHEET NUMBER 9

(Joins sheet 2)

9

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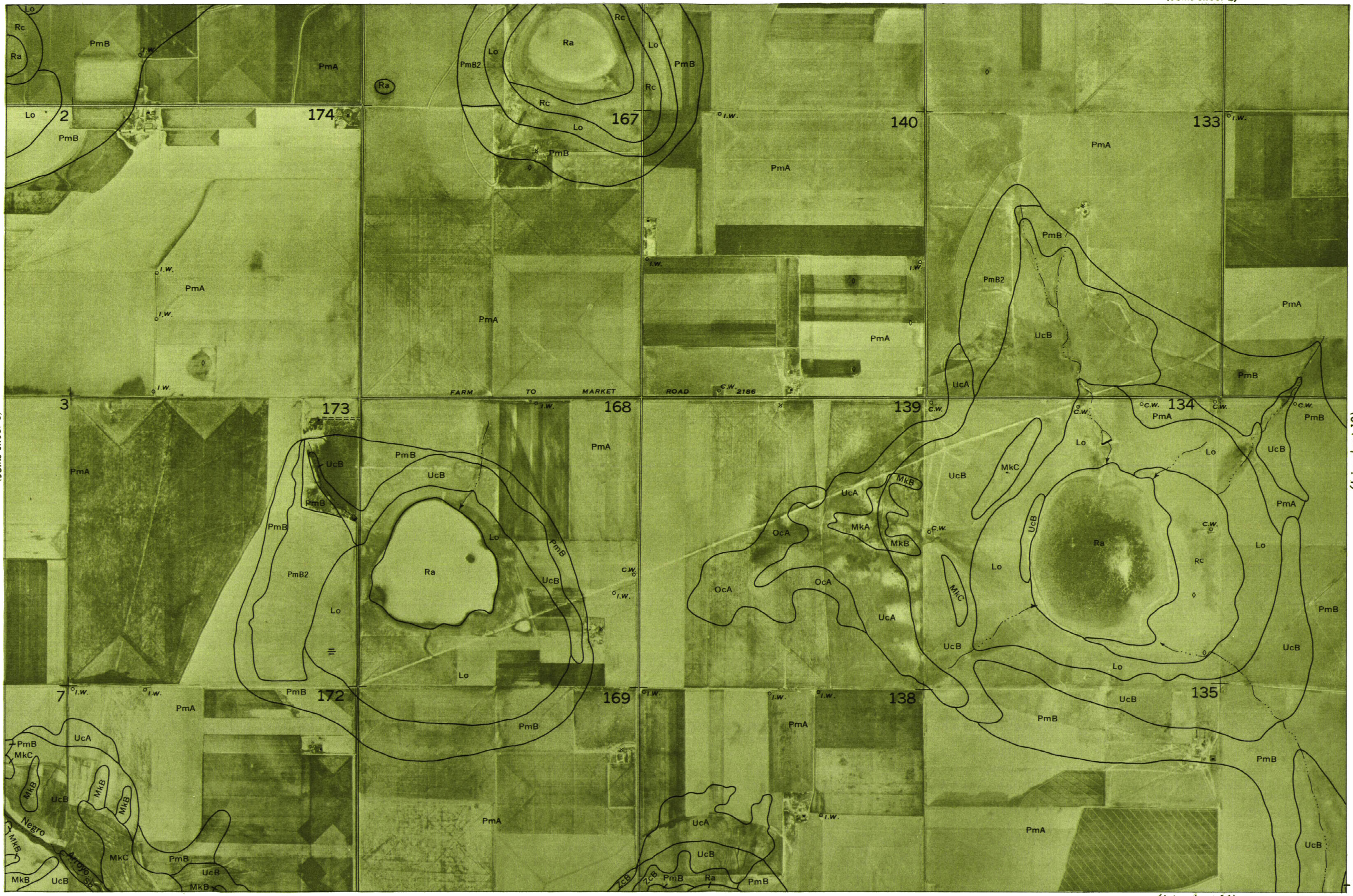
RANDALL COUNTY, TEXAS NO. 9

(Joins sheet 8)



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(Joins sheet 16)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

10

(Joins sheet 3)

N

(Joins sheet 9)

(Joins sheet 11)

(Joins sheet 17)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 10

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(Joins sheet 4)

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RANDALL COUNTY, TEXAS NO. 11

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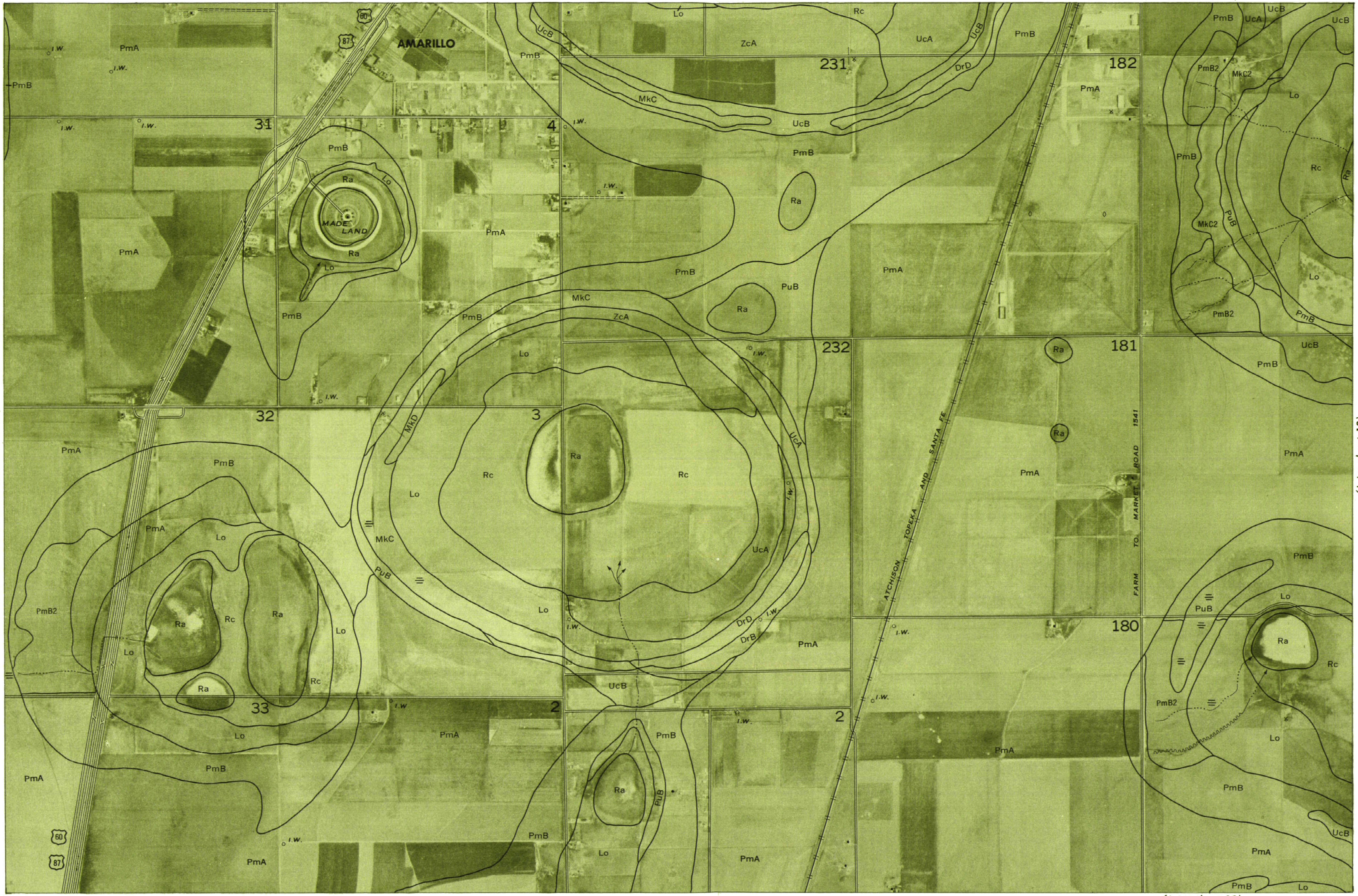

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RANDALL COUNTY, TEXAS — SHEET NUMBER 12

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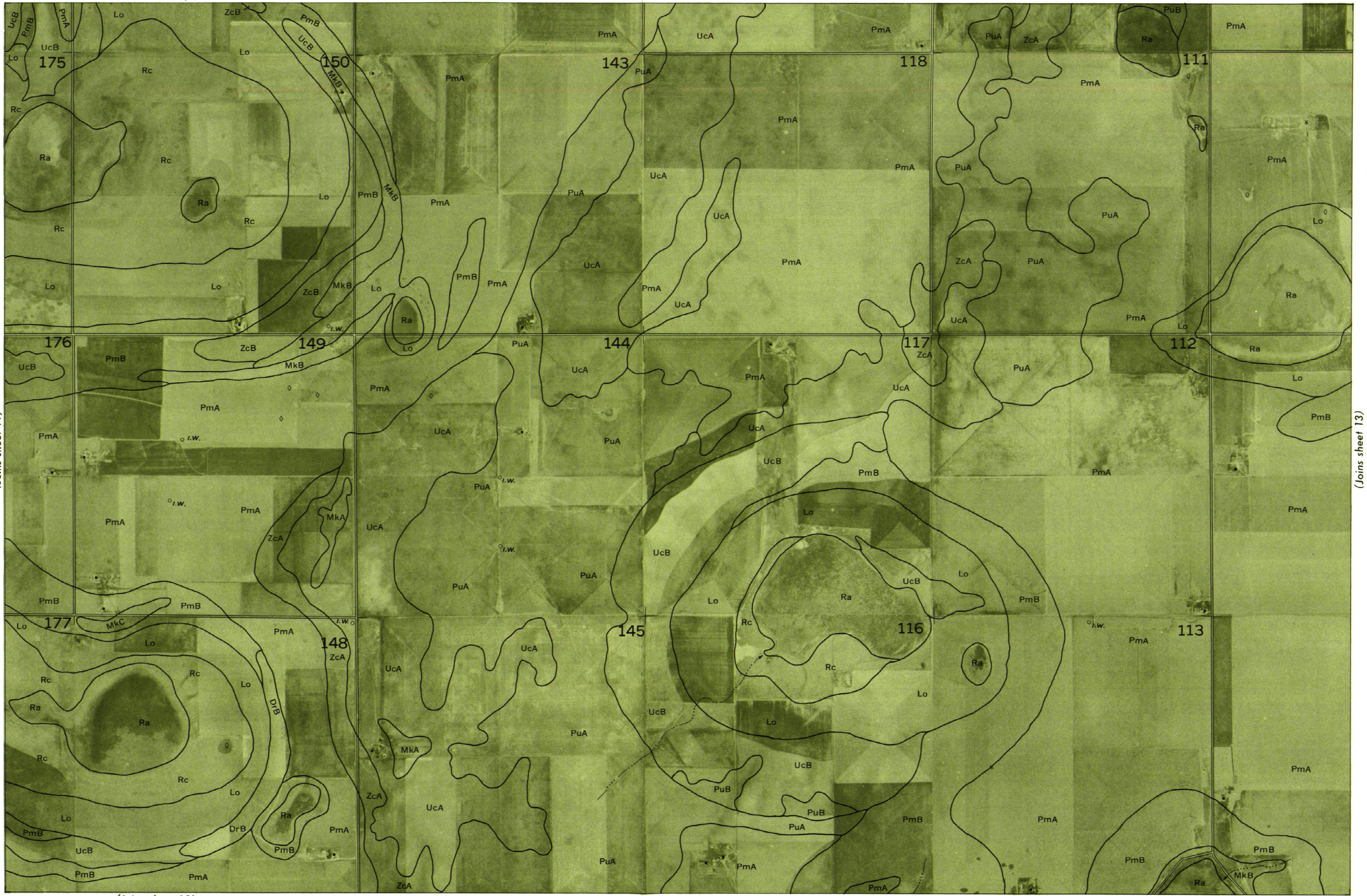

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(Joins sheet 19)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

RANDALL COUNTY, TEXAS NO. 12

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RANDALL COUNTY, TEXAS — SHEET NUMBER 13

13

(Joins sheet 6)

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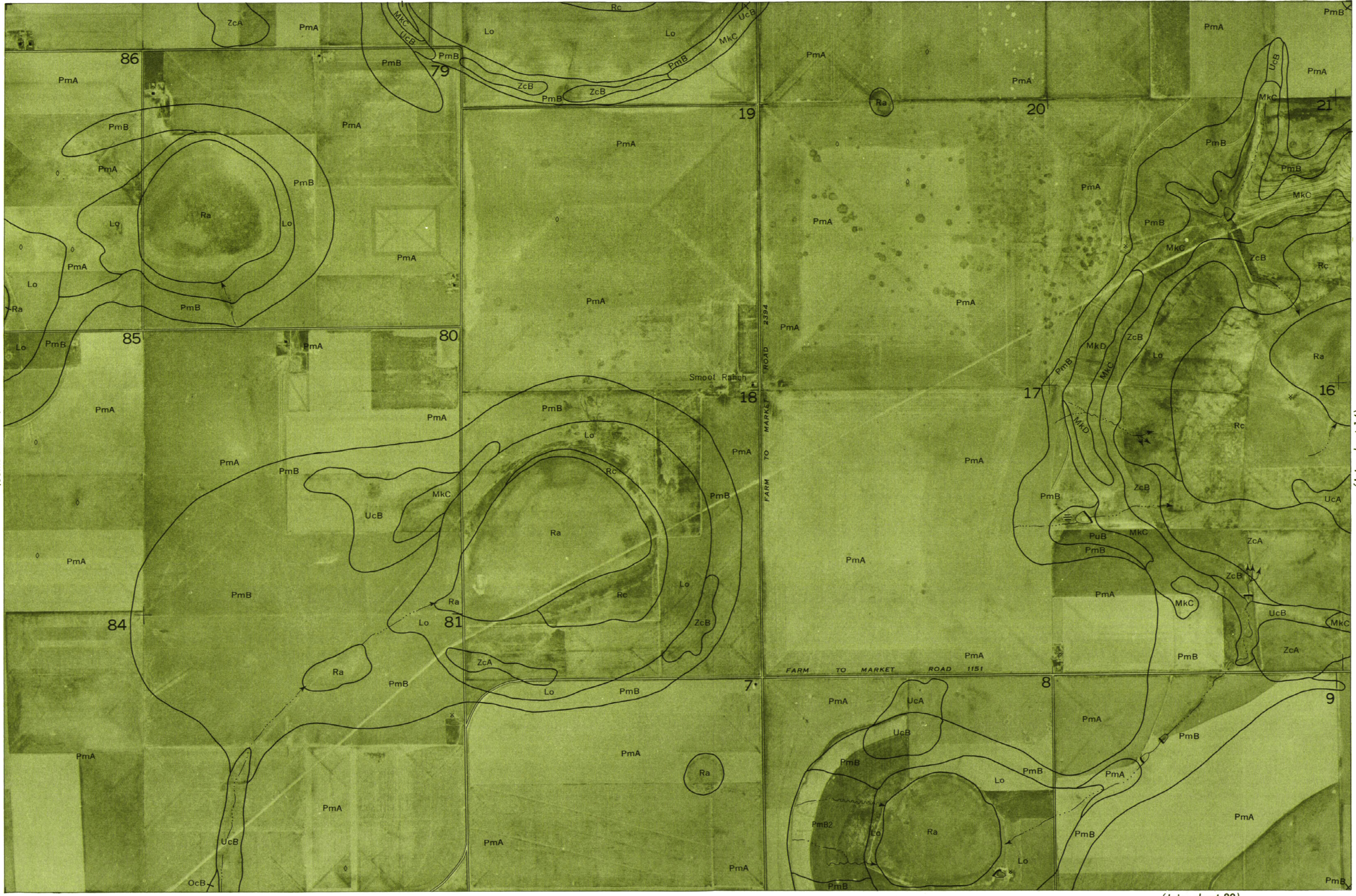
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 13

(Joins sheet 12)



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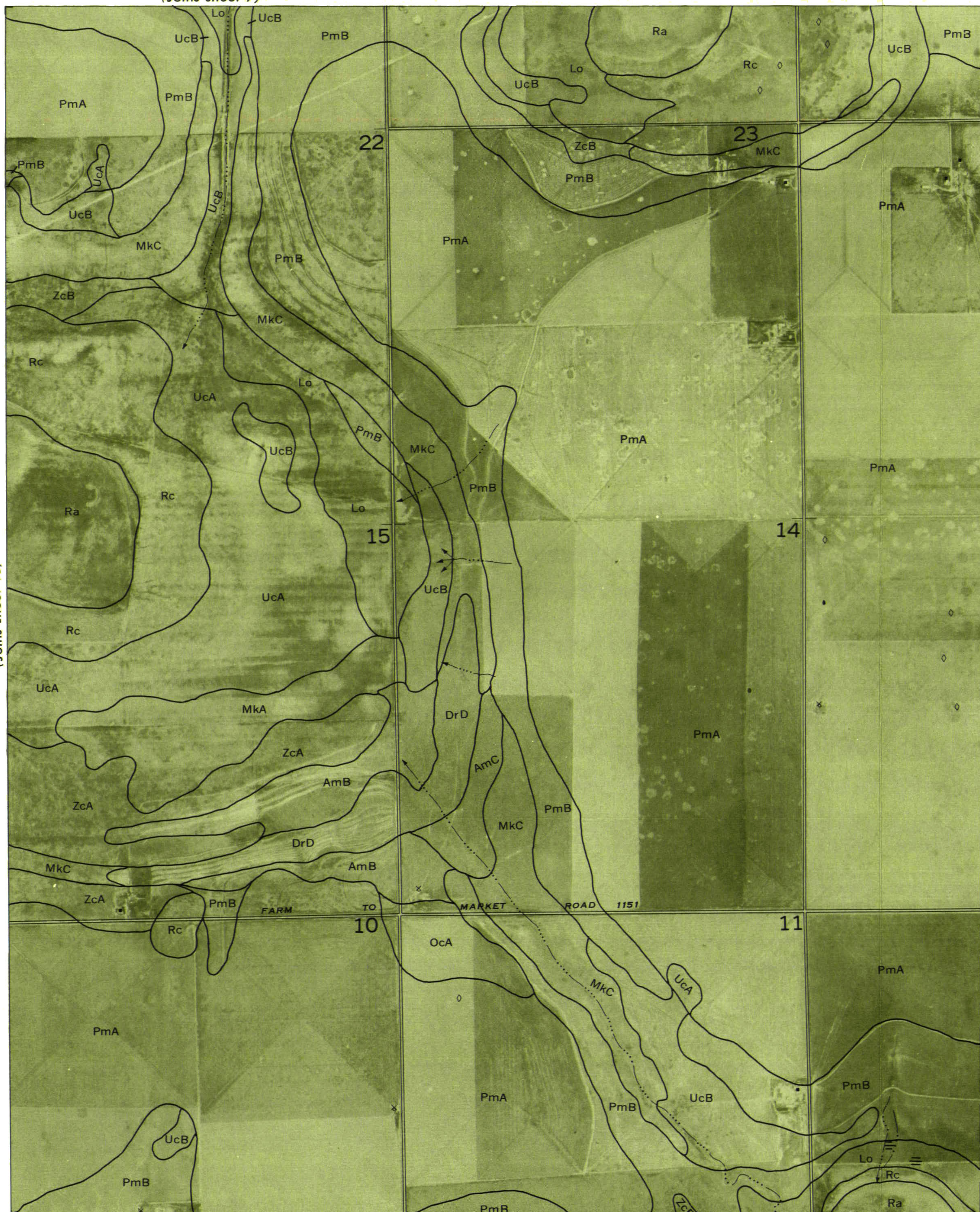
14



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 14

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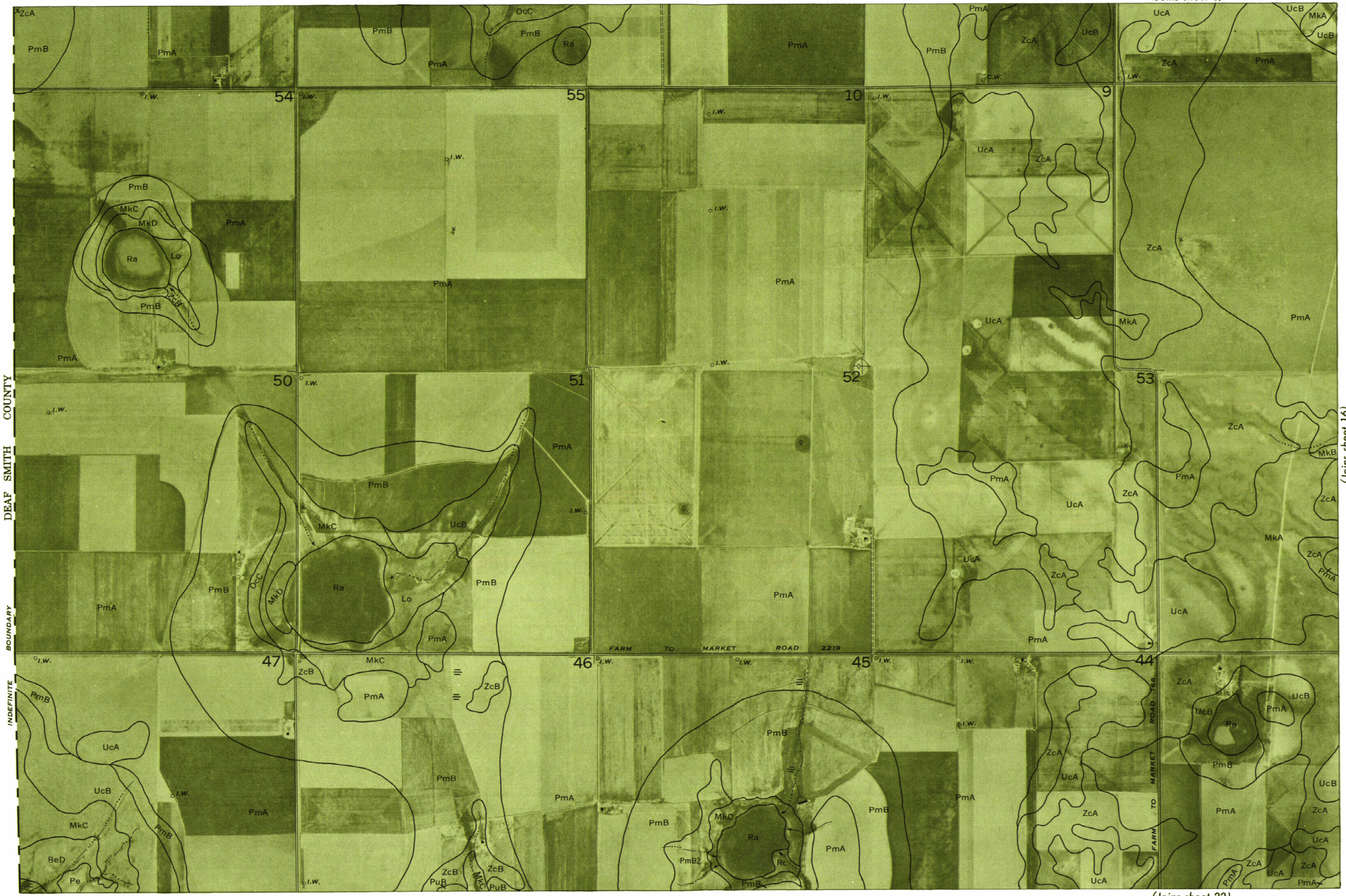
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 15



0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

16

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N

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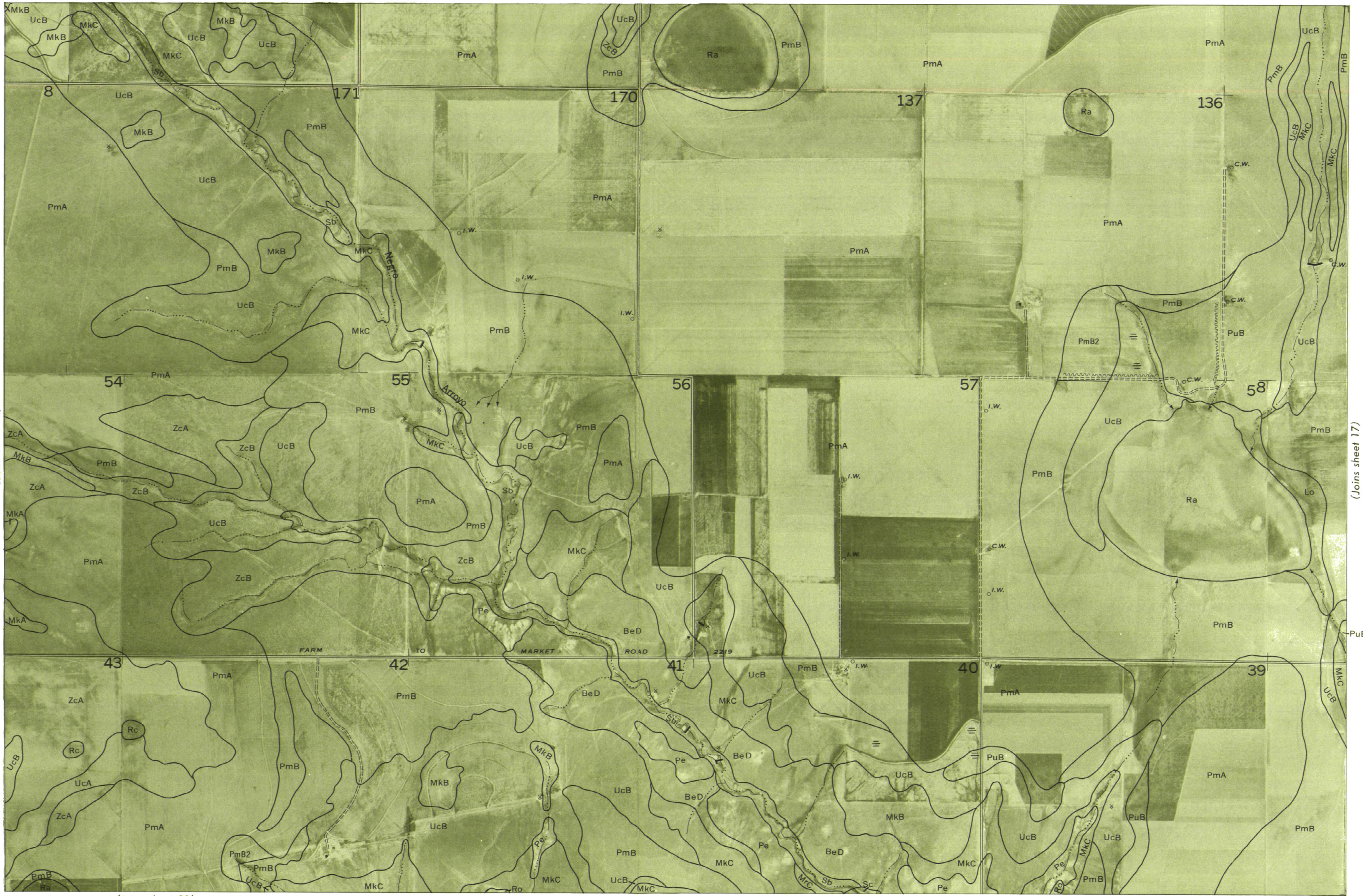

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(Joins sheet 23)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

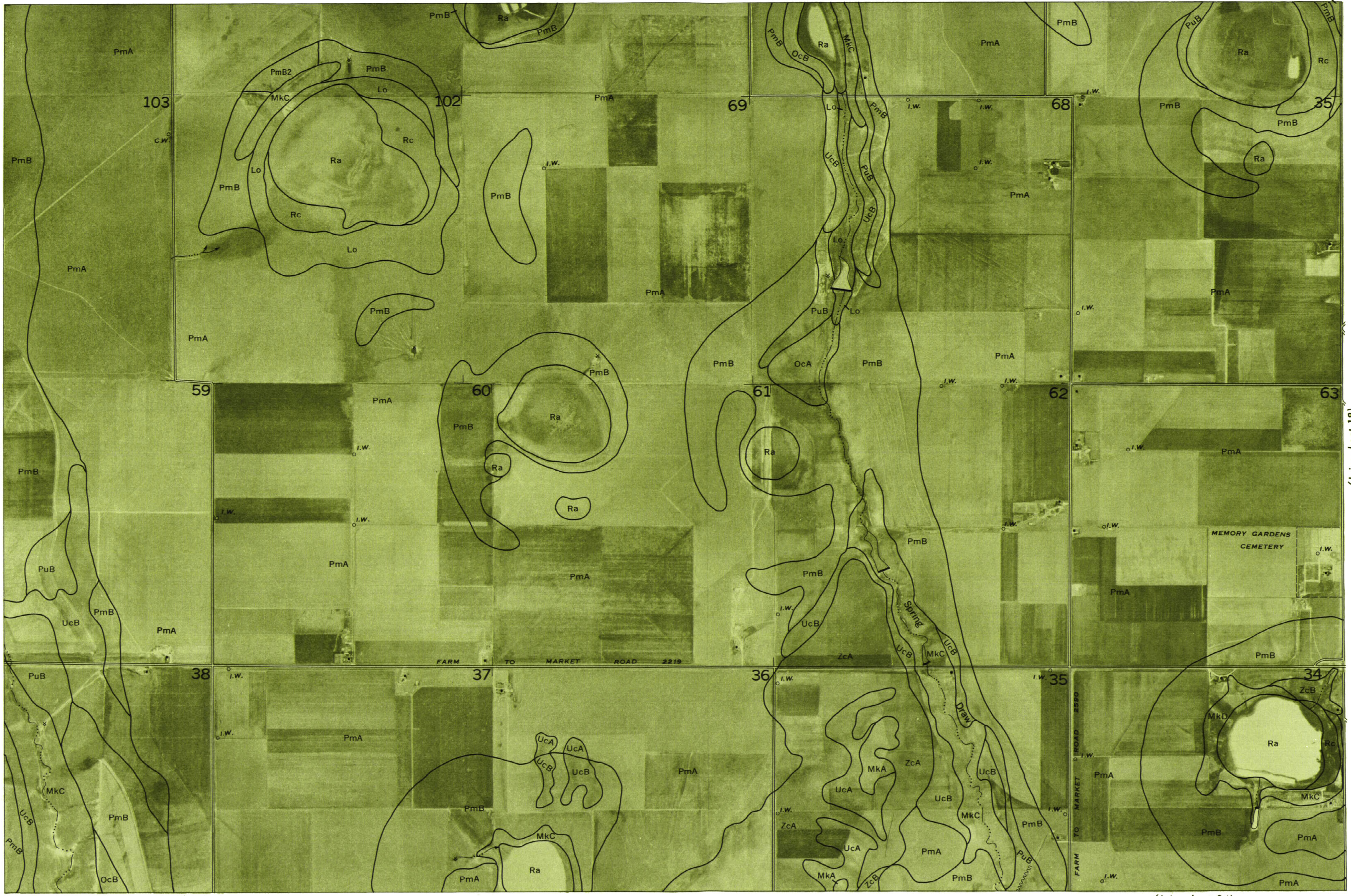
RANDALL COUNTY, TEXAS NO. 16

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

(17)

(Joins sheet 10)



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(Joins sheet 18)

(Joins sheet 24)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

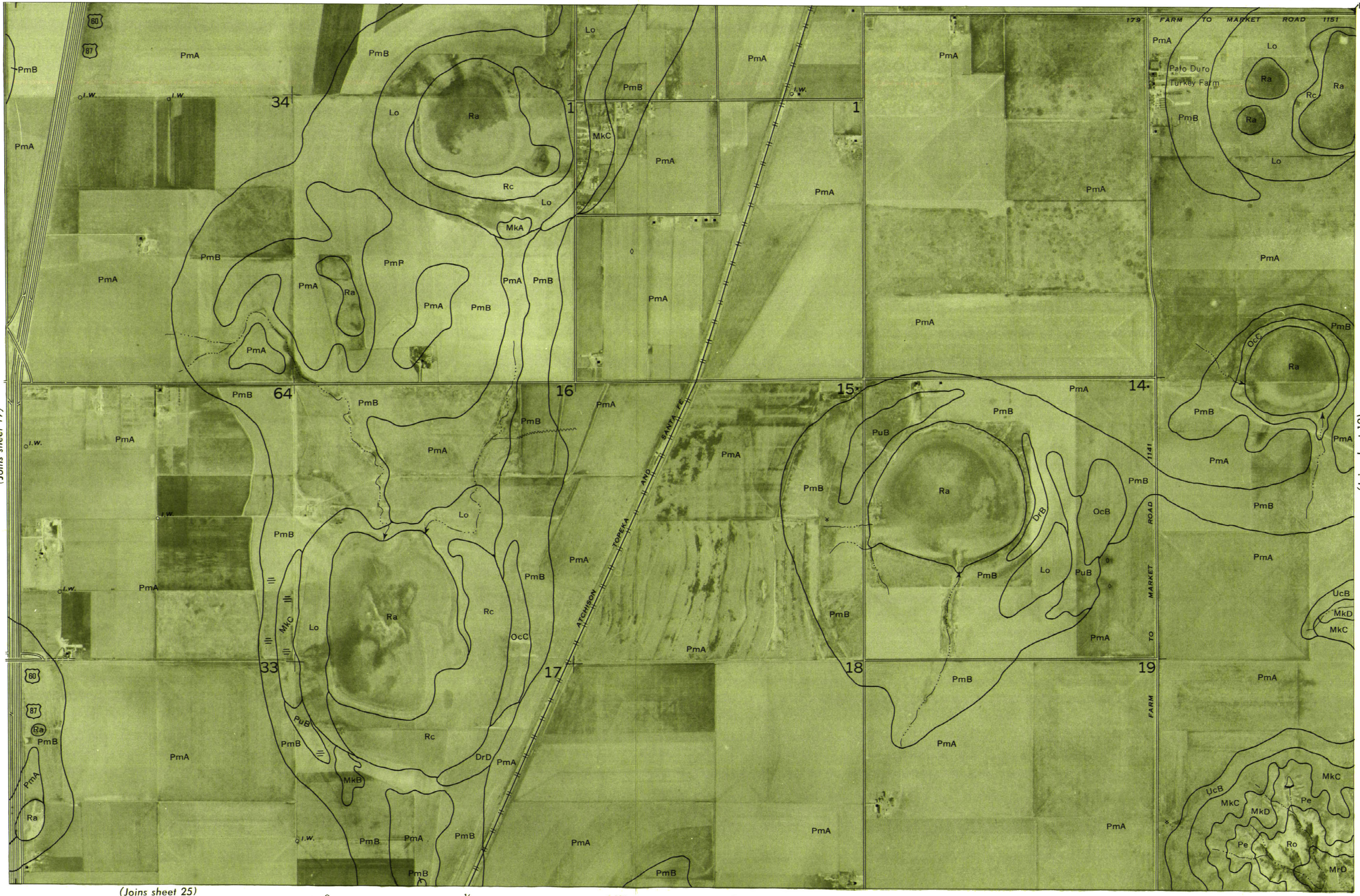
This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 17

18

(Joins sheet 11)

(Joins sheet 17)



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0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

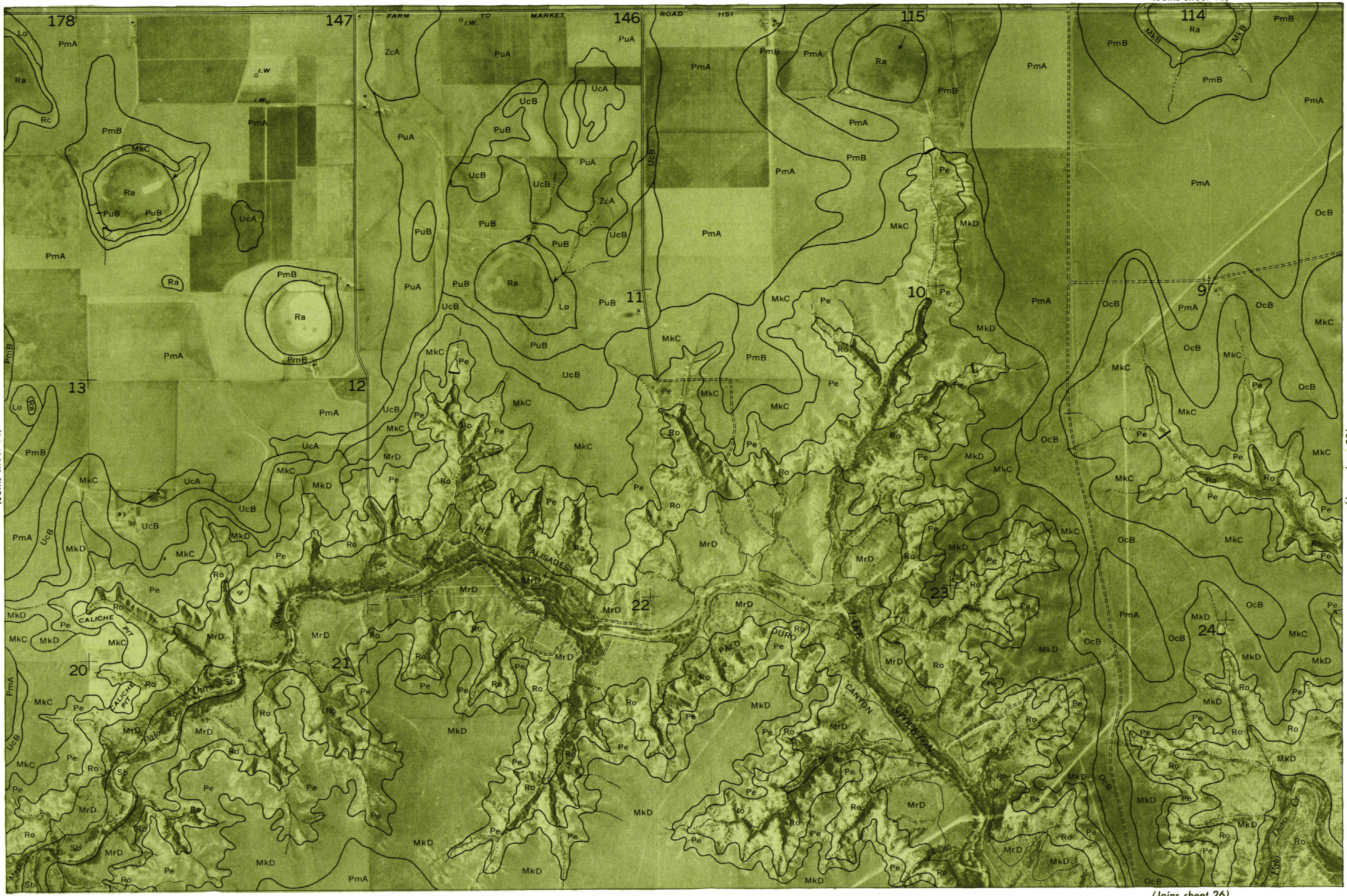
RANDALL COUNTY, TEXAS NO. 18

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

(Joins sheet 12)

N



(Joins sheet 18)

(Joins sheet 20)

(Joins sheet 26)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS — SHEET NUMBER 20

(Joins sheet 13)

N

(Joins sheet 19)

(Joins sheet 21)

(Joins sheet 27)

0 ½ 1 Mile

Scale 1: 20 000

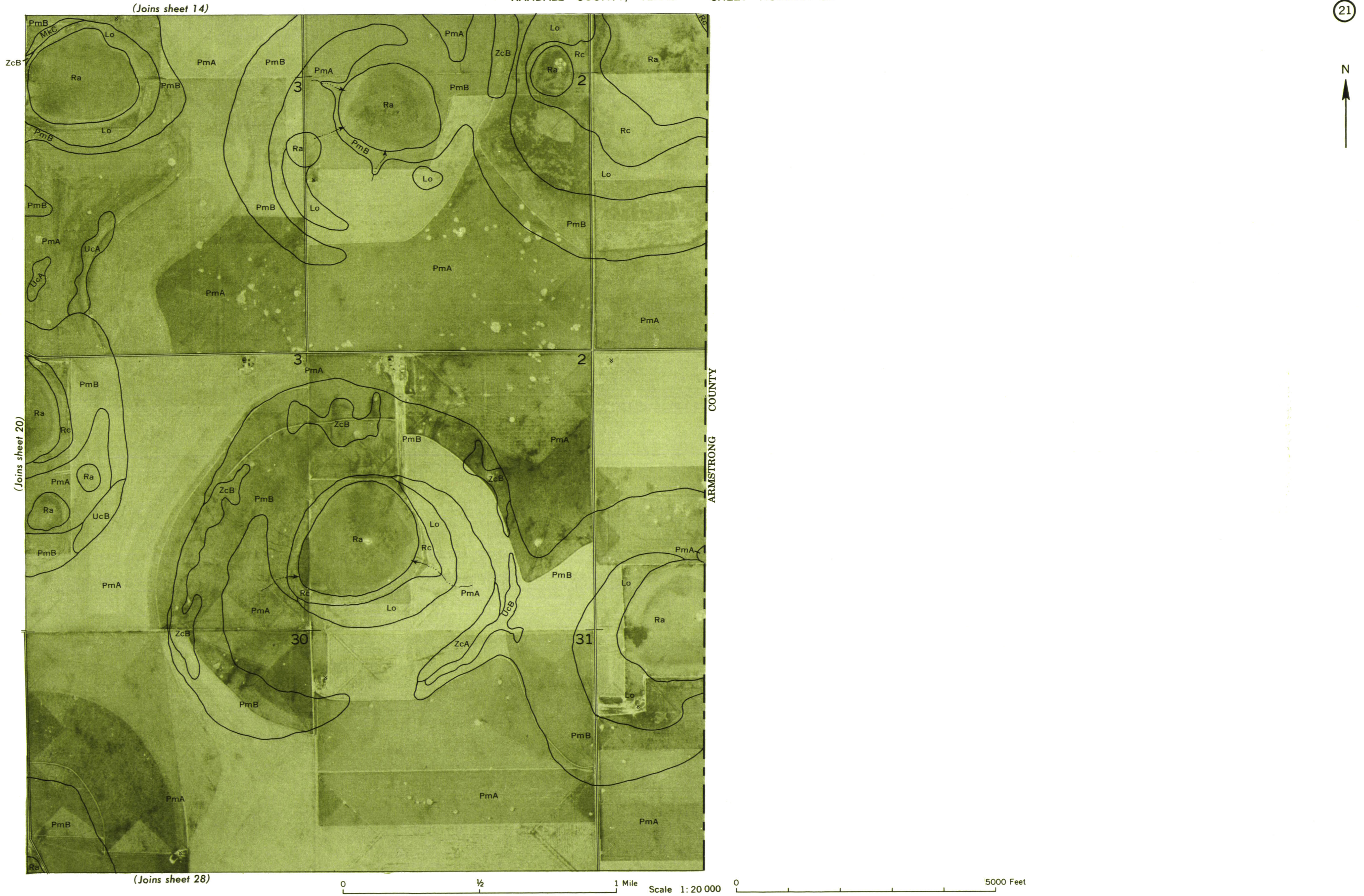
0 5000 Feet

RANDALL COUNTY, TEXAS NO. 20

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

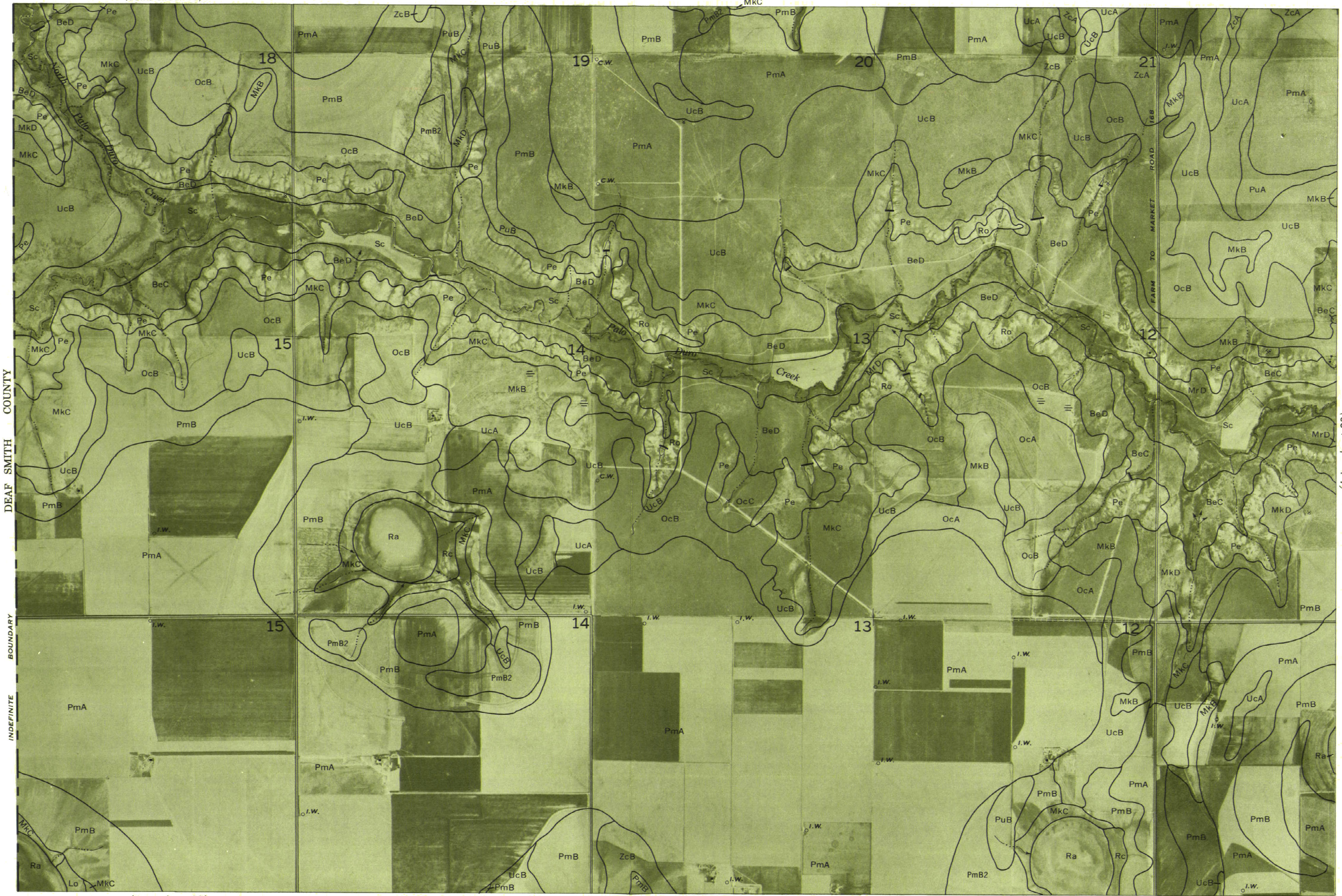
RANDALL COUNTY, TEXAS NO. 21



RANDALL COUNTY, TEXAS — SHEET NUMBER 22

(Joins sheet 15)

N



(Joins sheet 23)

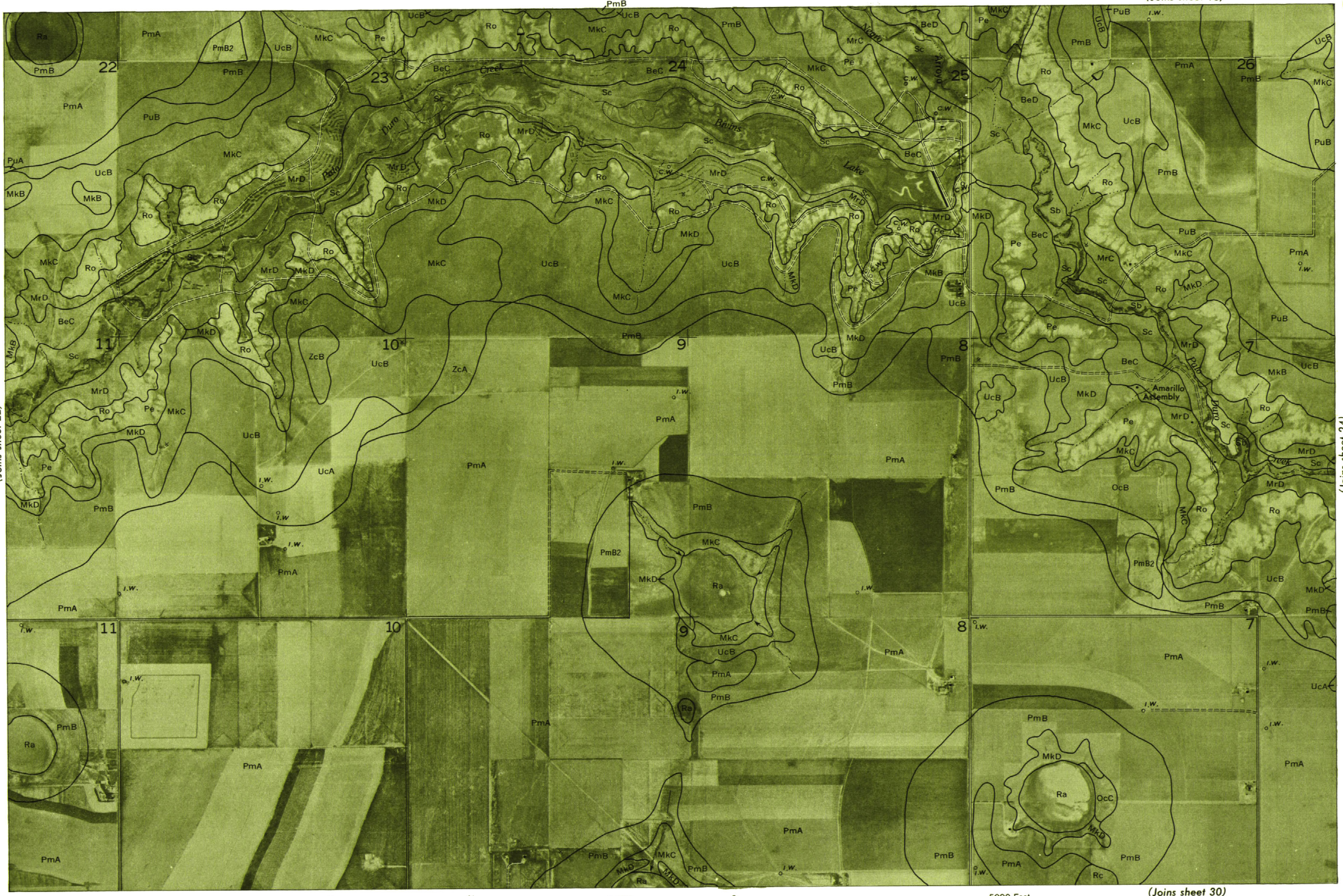
(Joins sheet 29)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 22

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

(Joins sheet 16)



(Joins sheet 22)

(Joins sheet 24)

(Joins sheet 30)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 23

24

(Joins sheet 17)

N

(Joins sheet 23)

(Joins sheet 25)

(Joins sheet 31)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 24

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

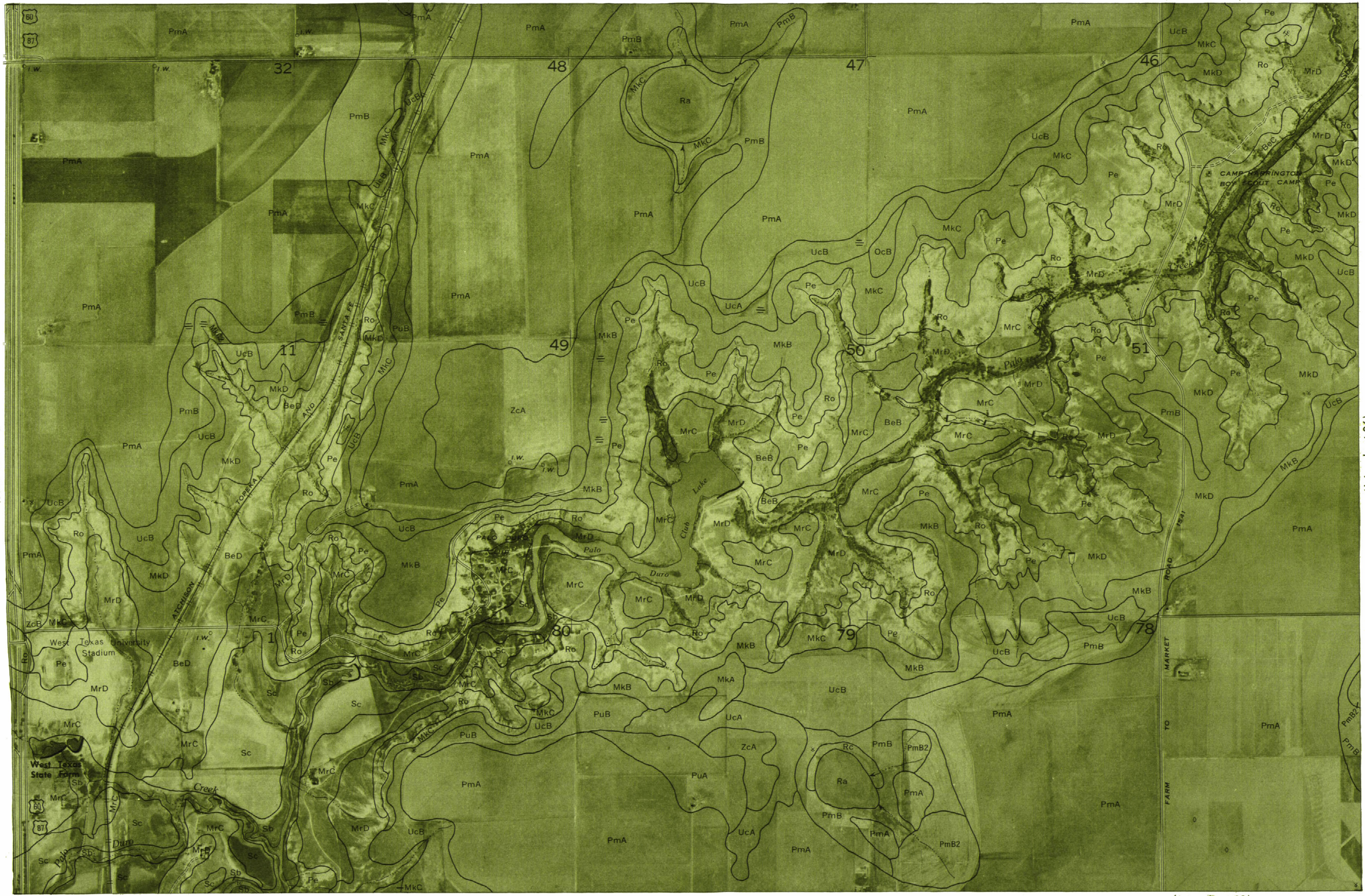
Land division corners are approximately positioned on this map.

(Joins sheet 18)

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 25

(Joins sheet 24)



(Joins sheet 26)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

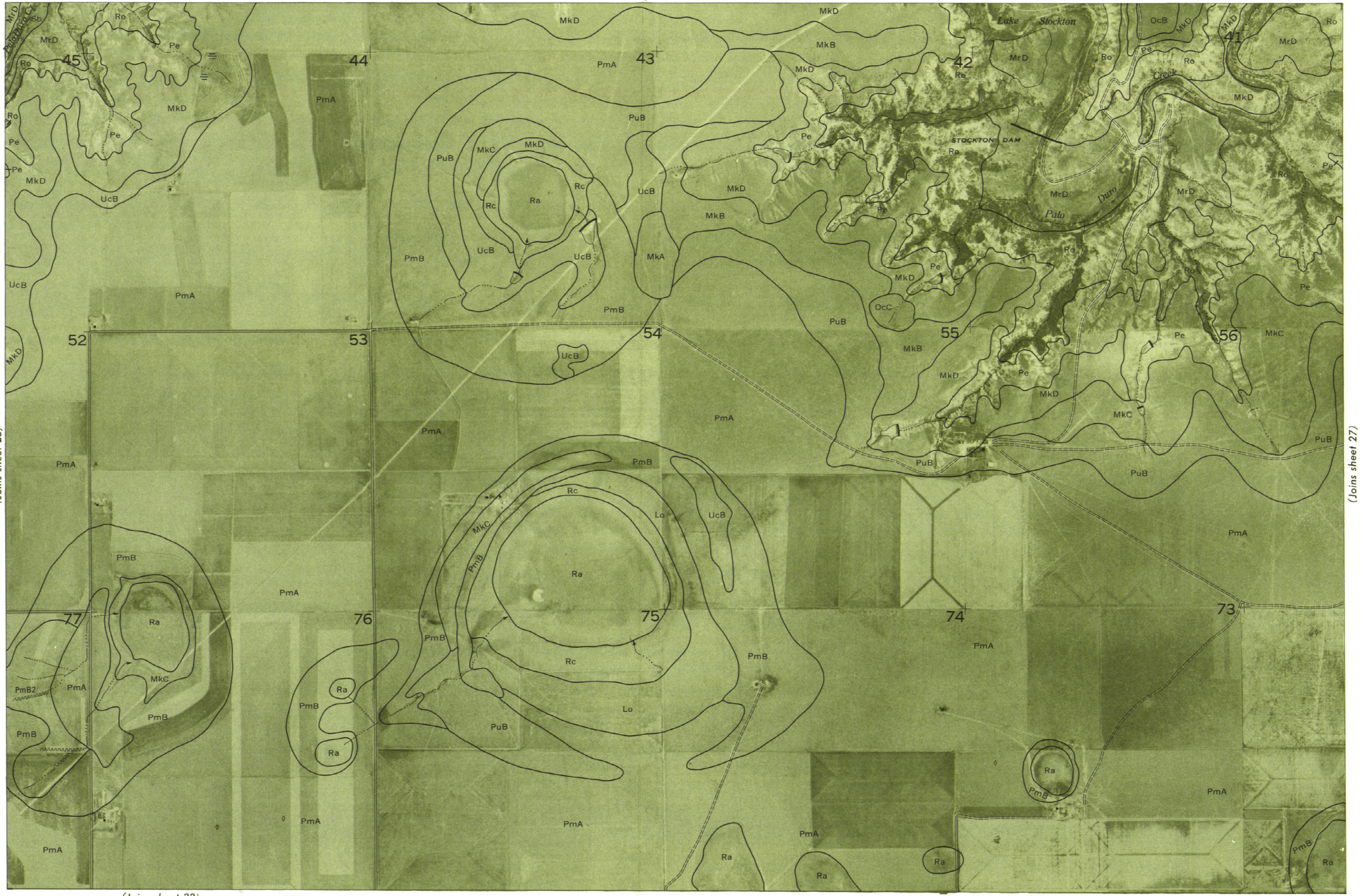
(Joins sheet 32)

(26) RANDALL COUNTY, TEXAS — SHEET NUMBER 26

(Joins sheet 19)

N

(Joins sheet 25)



(Joins sheet 27)

(Joins sheet 33)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 26

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

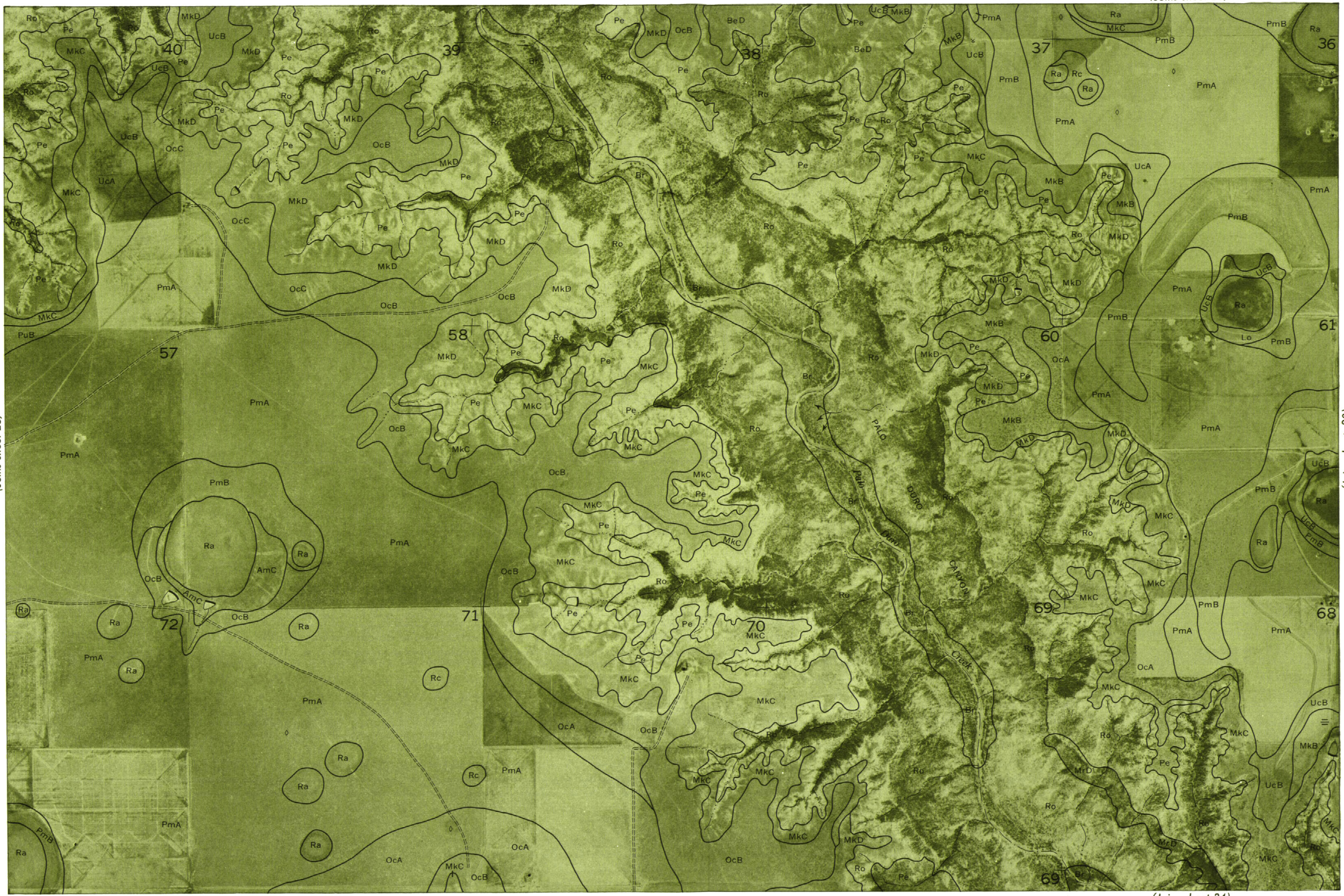
Land division corners are approximately positioned on this map.

(Joins sheet 20)

27

N

(Joins sheet 26)



(Joins sheet 28)

(Joins sheet 34)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

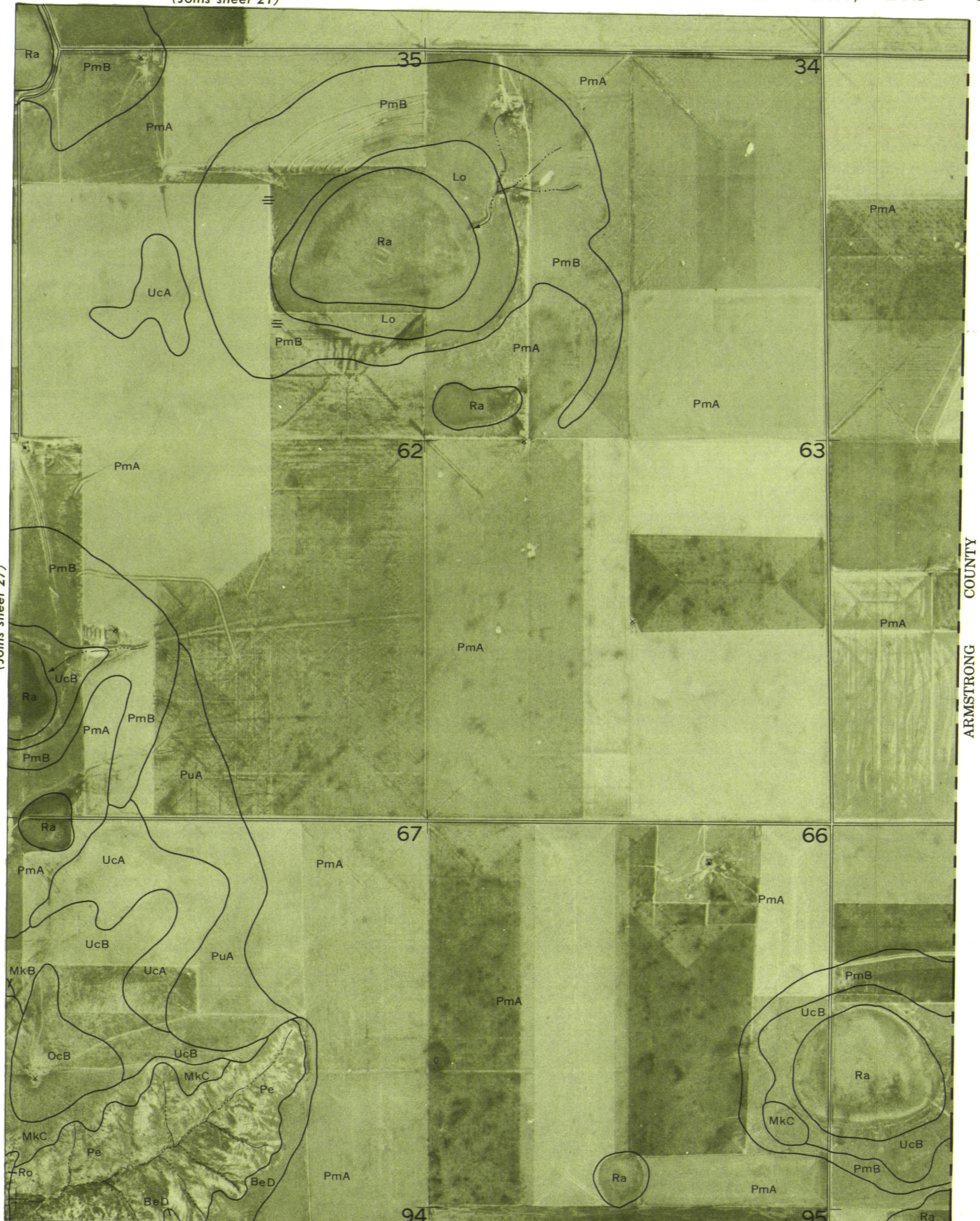
This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 27

(Joins sheet 21)

N

(Joins sheet 27)



(Joins sheet 35)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

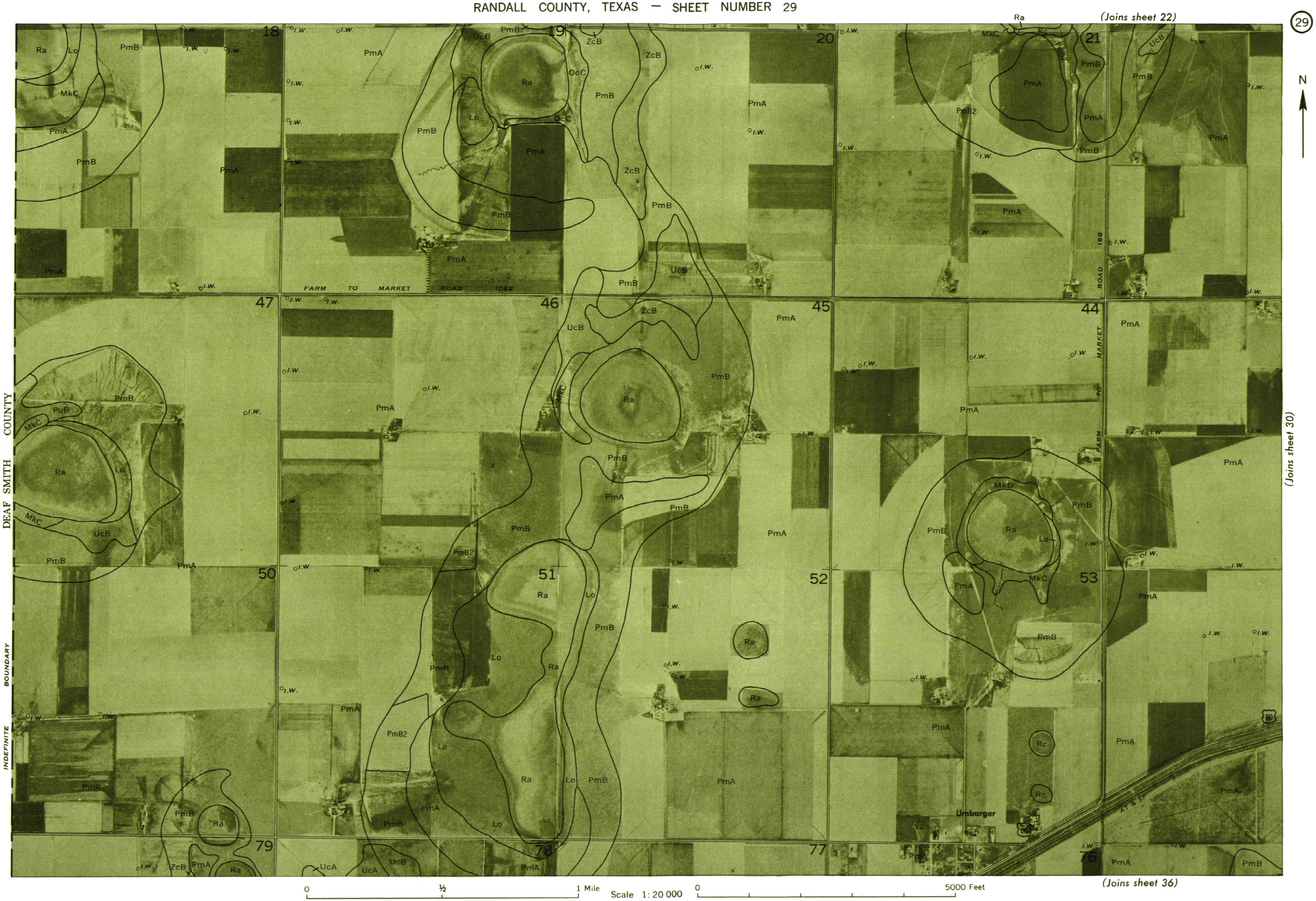
RANDALL COUNTY, TEXAS NO. 28

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS — SHEET NUMBER 29

29



0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

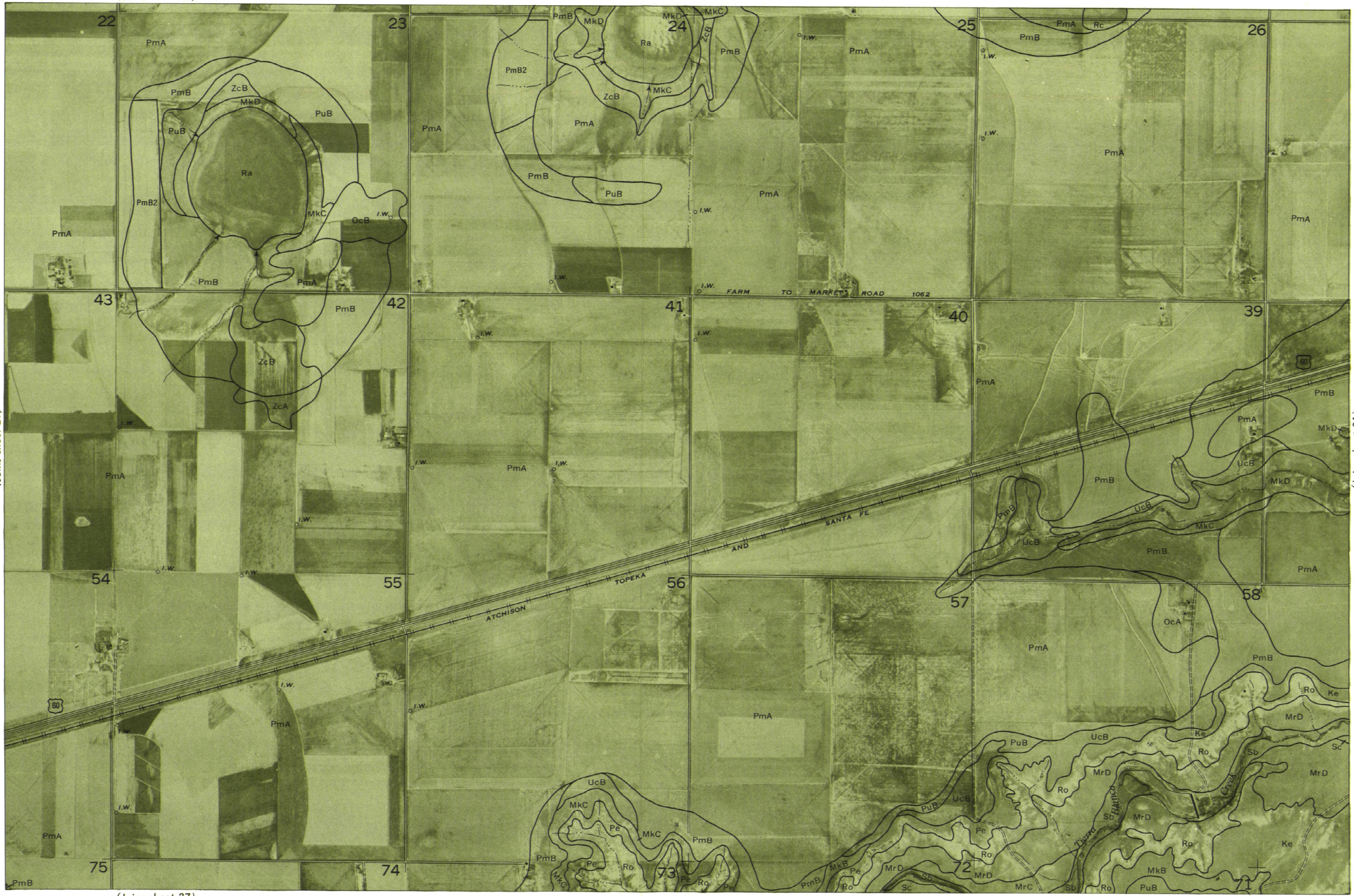
This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 29

30

(Joins sheet 23)



(Joins sheet 29)

(Joins sheet 31)

(Joins sheet 37)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 30

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

(Joins sheet 24)

31

(Joins sheet 30)

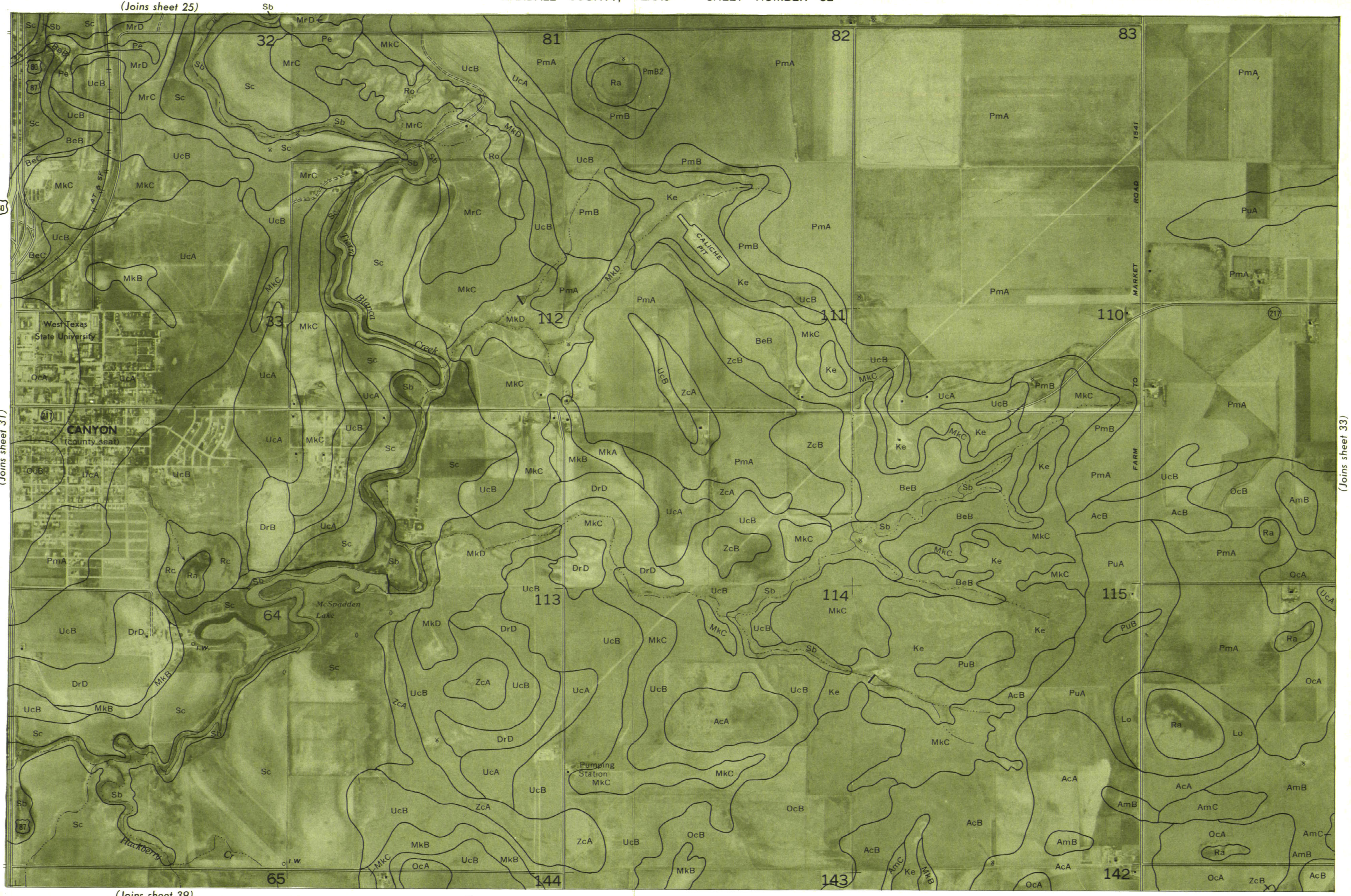
(Joins sheet 32)

(Joins sheet 38)

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 31

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



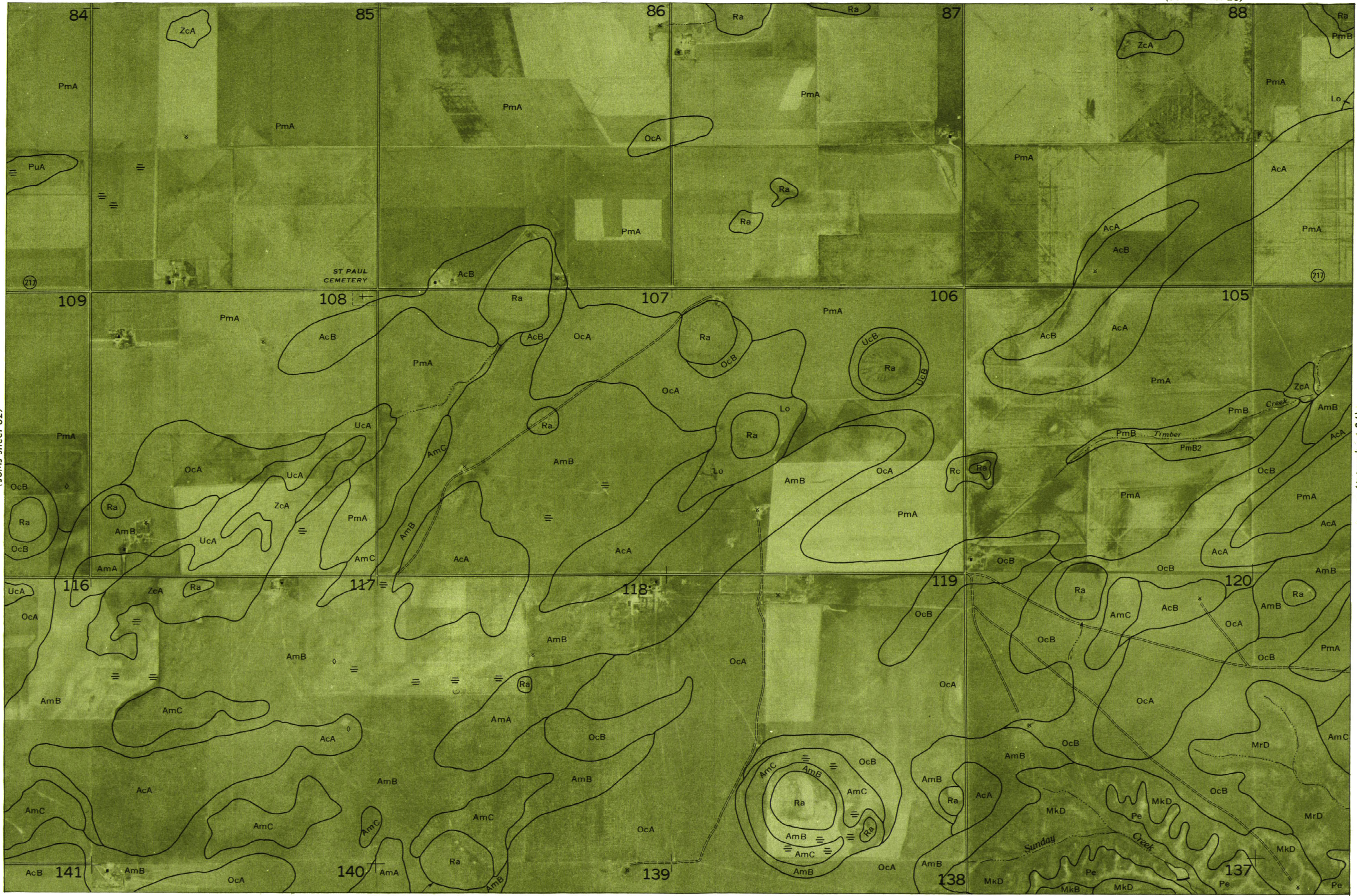
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 32

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station. Land division corners are approximately positioned on this map.

(Joins sheet 26)

33



(Joins sheet 32)

(Joins sheet 34)

(Joins sheet 40)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

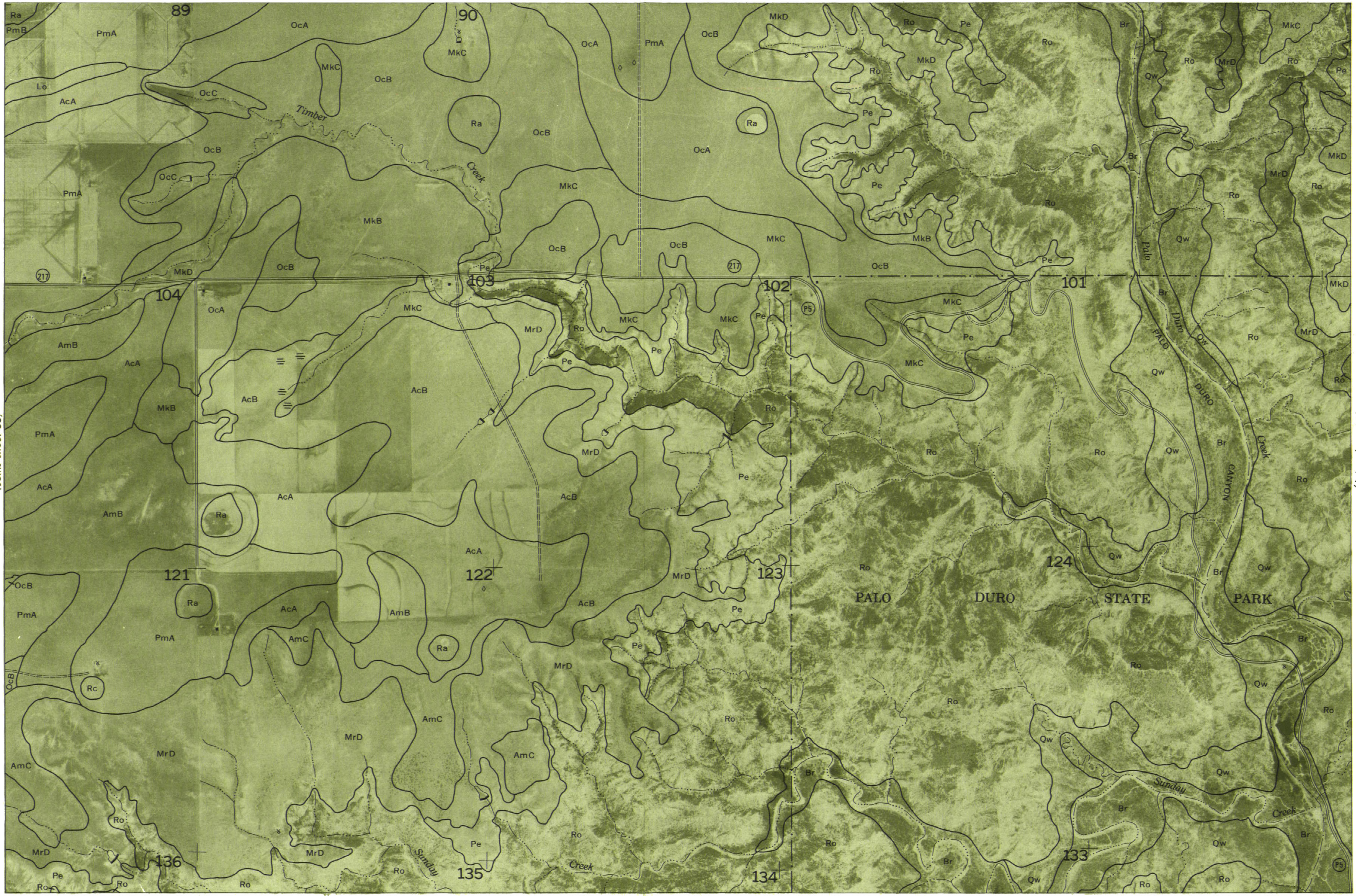
N

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 33

(Joins sheet 27)

(Joins sheet 33)



(Joins sheet 35)

(Joins sheet 41)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

N

(Joins sheet 28)

(Joins sheet 34)

(Joins sheet 42)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station

Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 35

(Joins sheet 29)

(Joins sheet 37)

(Joins sheet 43)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS — SHEET NUMBER 37

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 37

N

(Joins sheet 31)

(Joins sheet 37)

(Joins sheet 39)

(Joins sheet 45)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 38

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station. Land division corners are approximately positioned on this map.

(39)

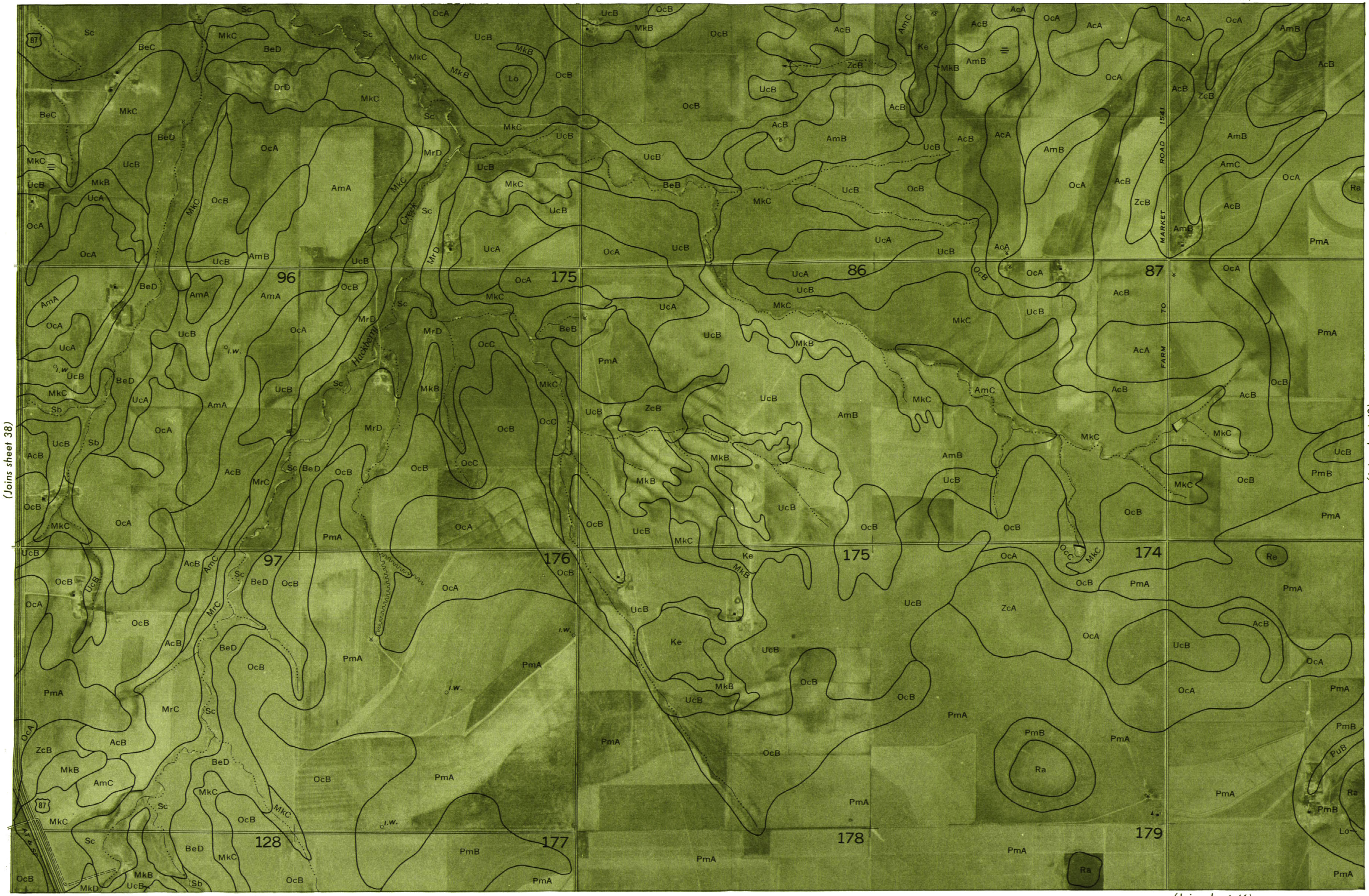
(Joins sheet 32)

N

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 39

(Joins sheet 38)



(Joins sheet 40)

(Joins sheet 46)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

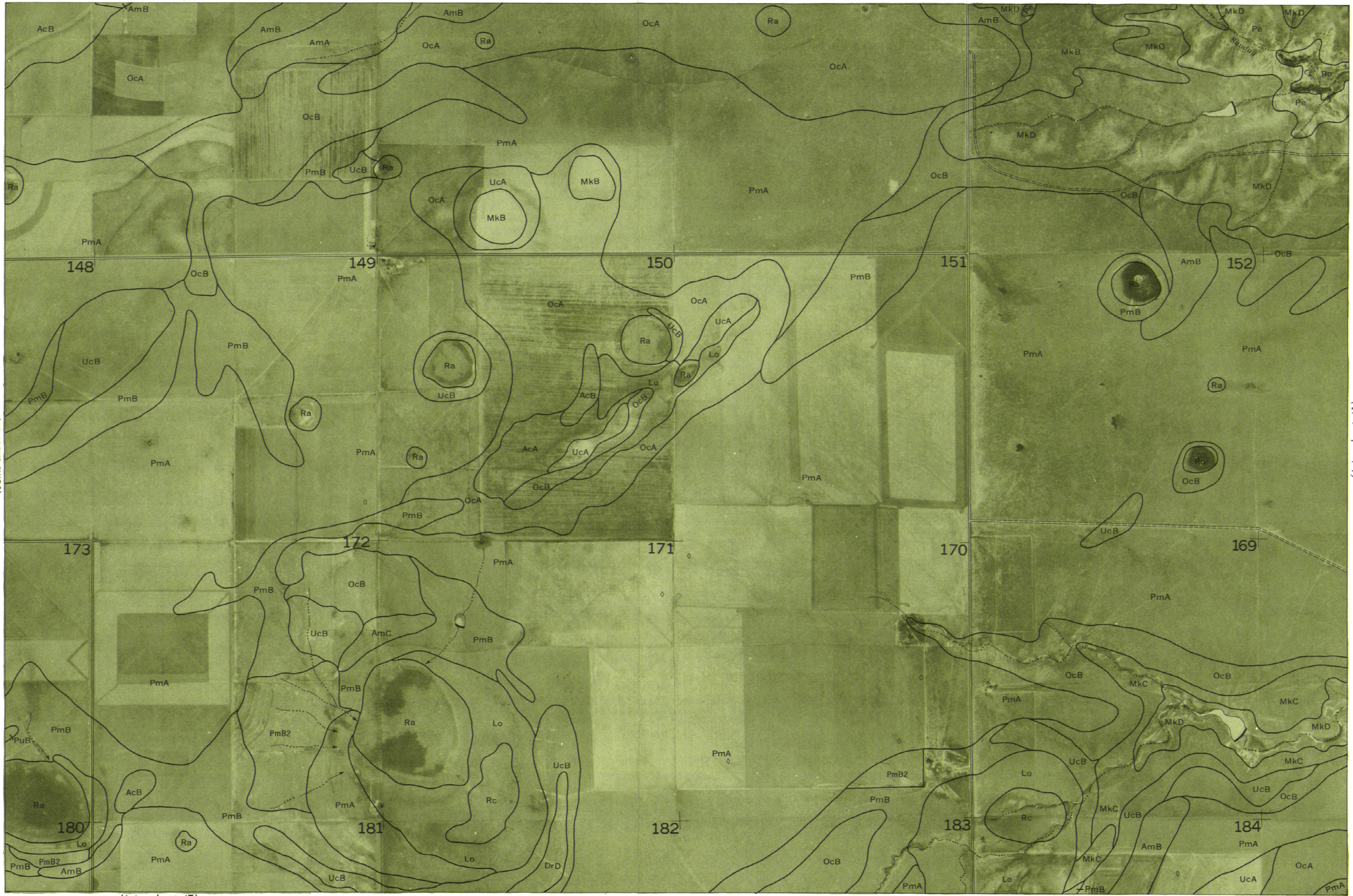
(40)

RANDALL COUNTY, TEXAS — SHEET NUMBER 40

(Joins sheet 33)

N

(Joins sheet 39)



(Joins sheet 41)

(Joins sheet 47)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 40

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

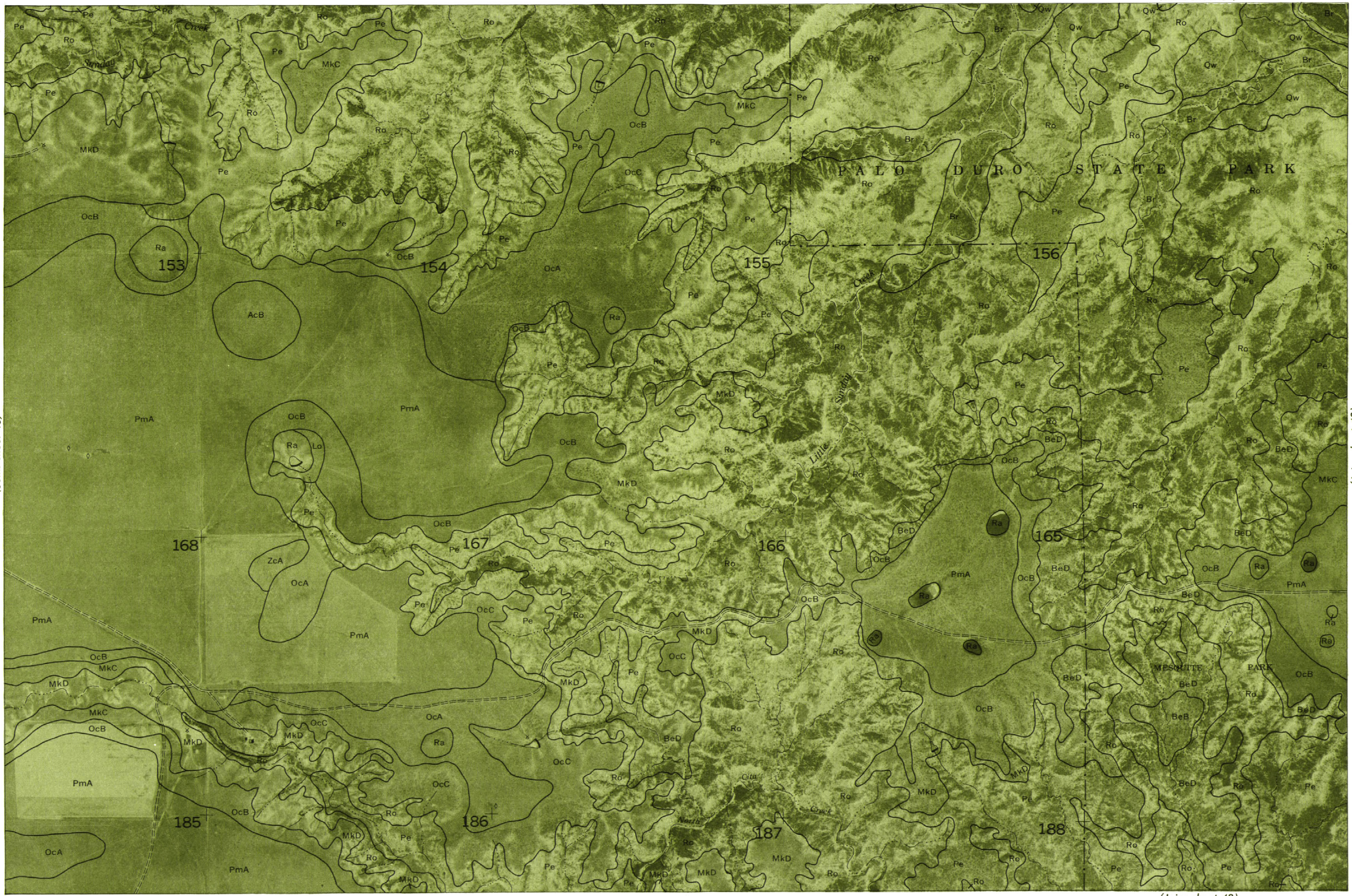
41

(Joins sheet 34)

(Joins sheet 40)

(Joins sheet 42)

N



(Joins sheet 48)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.
RANDALL COUNTY, TEXAS NO. 41

42

(Joins sheet 35)

N

(Joins sheet 41)

(Joins sheet 49)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

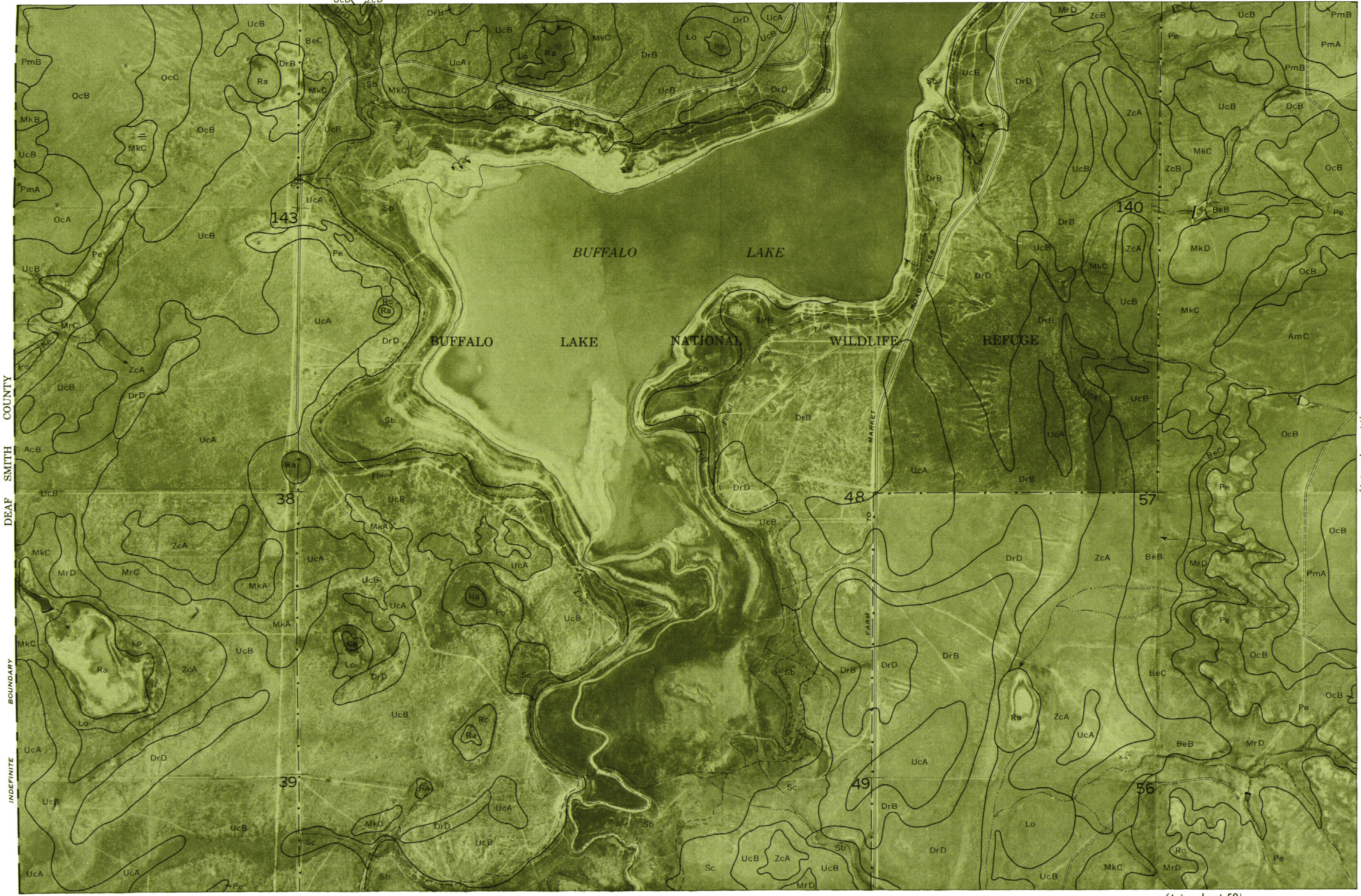
RANDALL COUNTY, TEXAS NO. 42

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

(Joins sheet 36)

N



(Joins sheet 44)

(Joins sheet 50)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

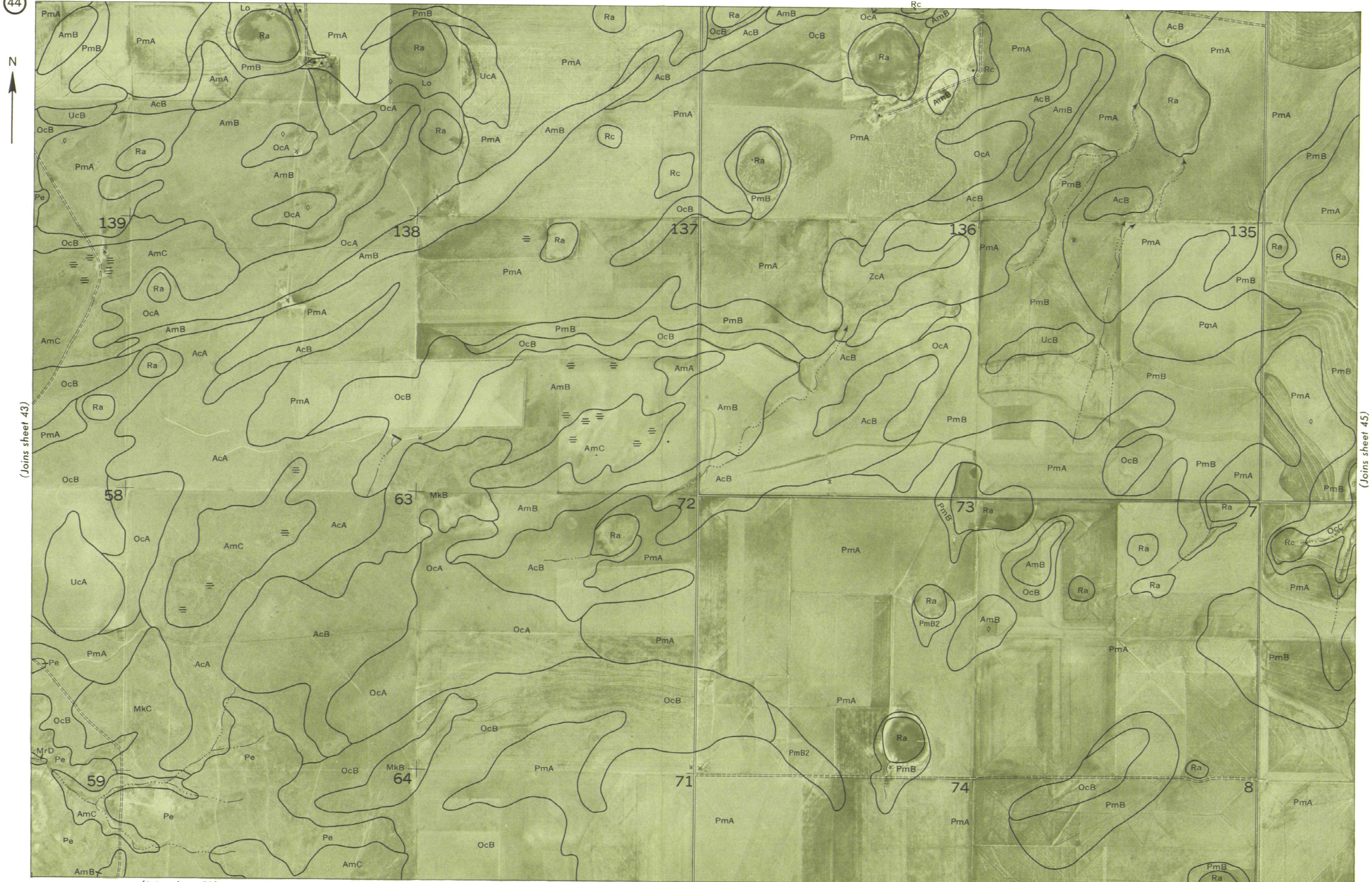
This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 43

RANDALL COUNTY, TEXAS — SHEET NUMBER 44

44

(Joins sheet 37)



(Joins sheet 43)

(Joins sheet 45)

(Joins sheet 51)

0 ½ 1 Mile

Scale 1: 20 000

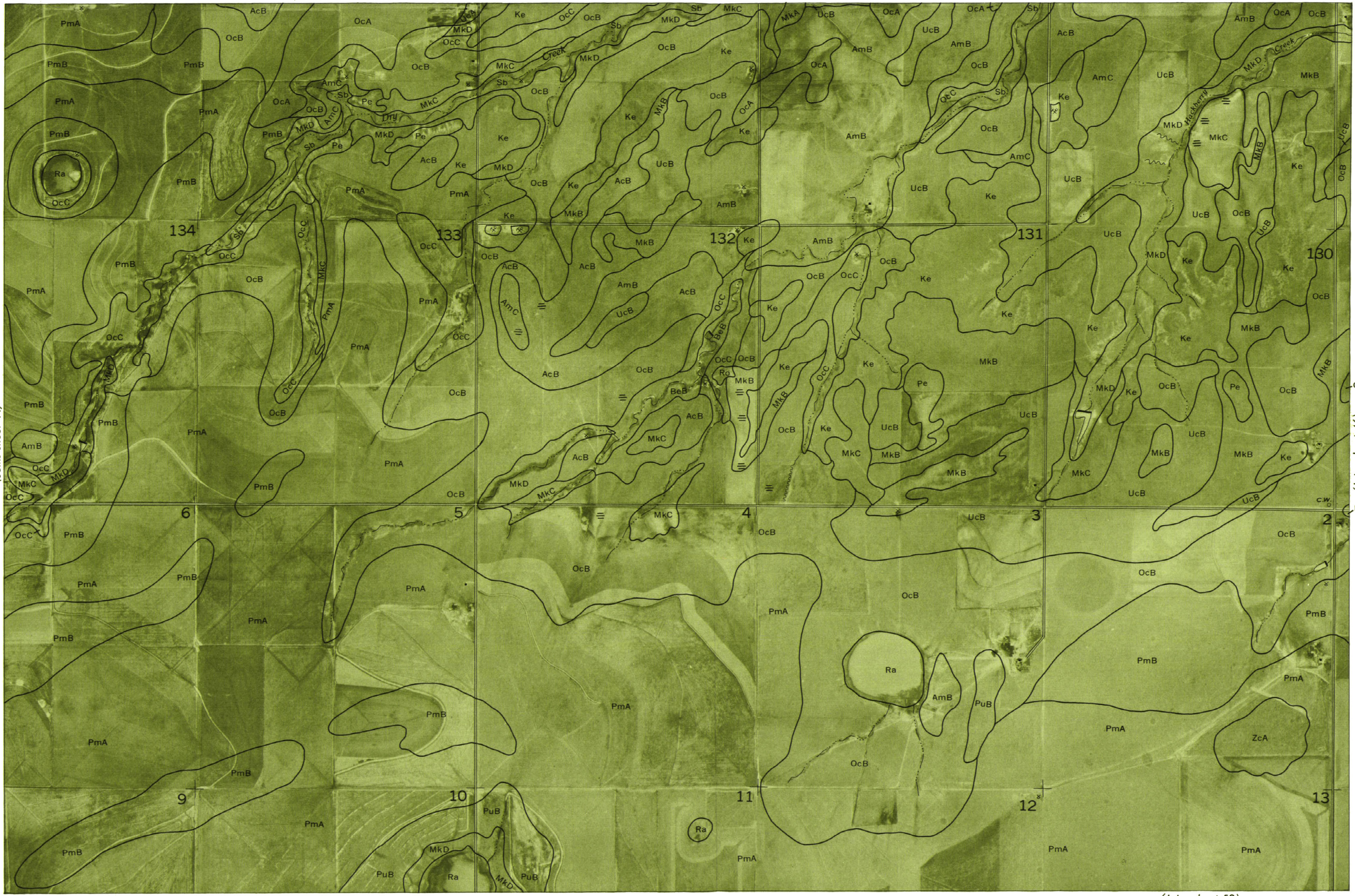
0 5000 Feet

RANDALL COUNTY, TEXAS NO. 44

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

(Joins sheet 38)

45



(Joins sheet 44)

(Joins sheet 46)

(Joins sheet 52)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 45

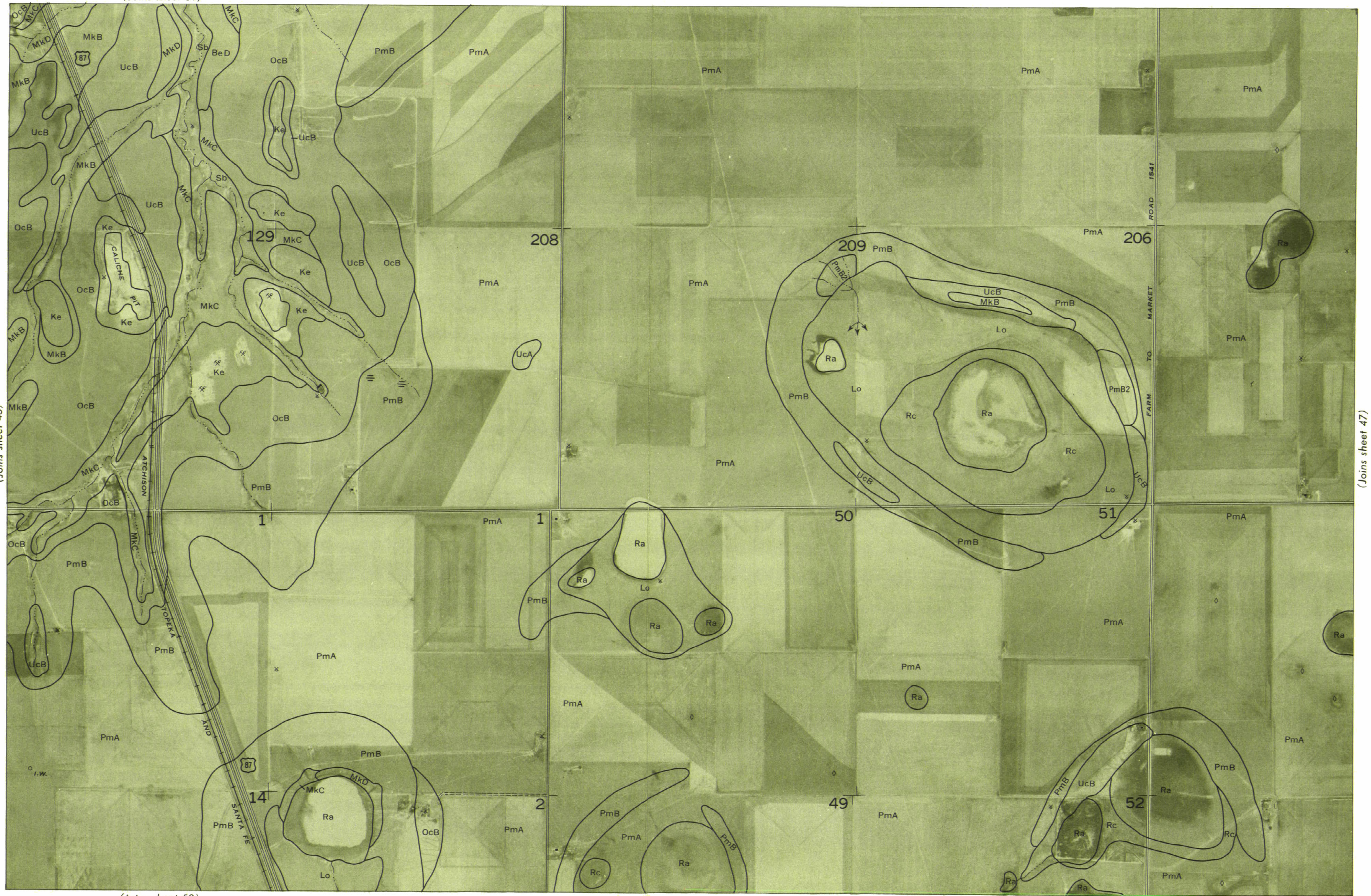
RANDALL COUNTY, TEXAS — SHEET NUMBER 46

46

(Joins sheet 39)

N

(Joins sheet 45)



(Joins sheet 47)

(Joins sheet 53)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

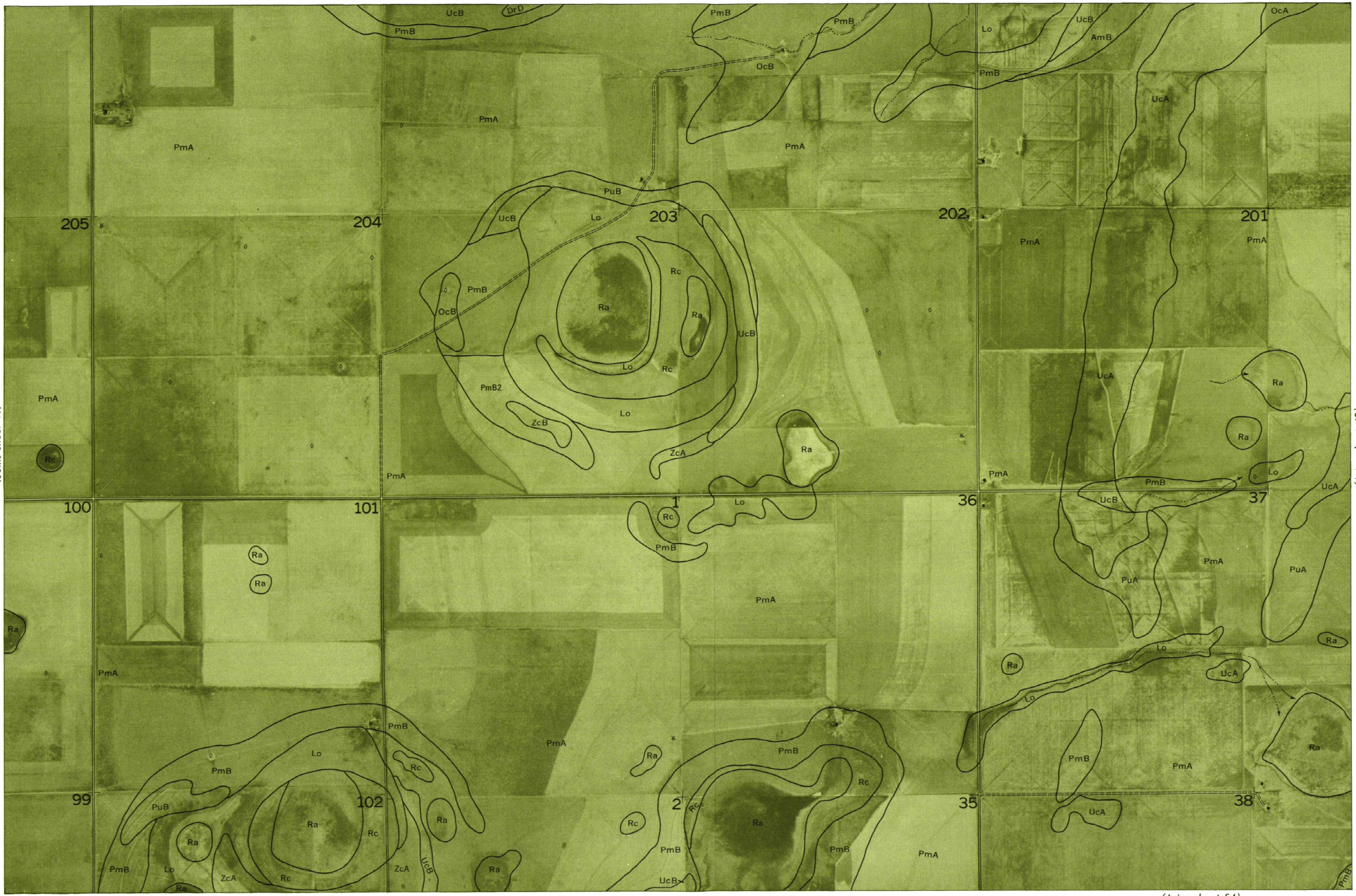
RANDALL COUNTY, TEXAS NO. 46

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS — SHEET NUMBER 47

47

(Joins sheet 40)



(Joins sheet 46)

(Joins sheet 48)

(Joins sheet 54)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station

Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 47

(Joins sheet 41)

N

(Joins sheet 47)

(Joins sheet 49)

(Joins sheet 55)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

RANDALL COUNTY, TEXAS NO. 48

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

(Joins sheet 42)

(Joins sheet 48)

(Joins upper right)

0 ½ 1 Mile

Scale 1: 20 000

(Joins lower left)

(Joins sheet 55)

(Joins sheet 62)

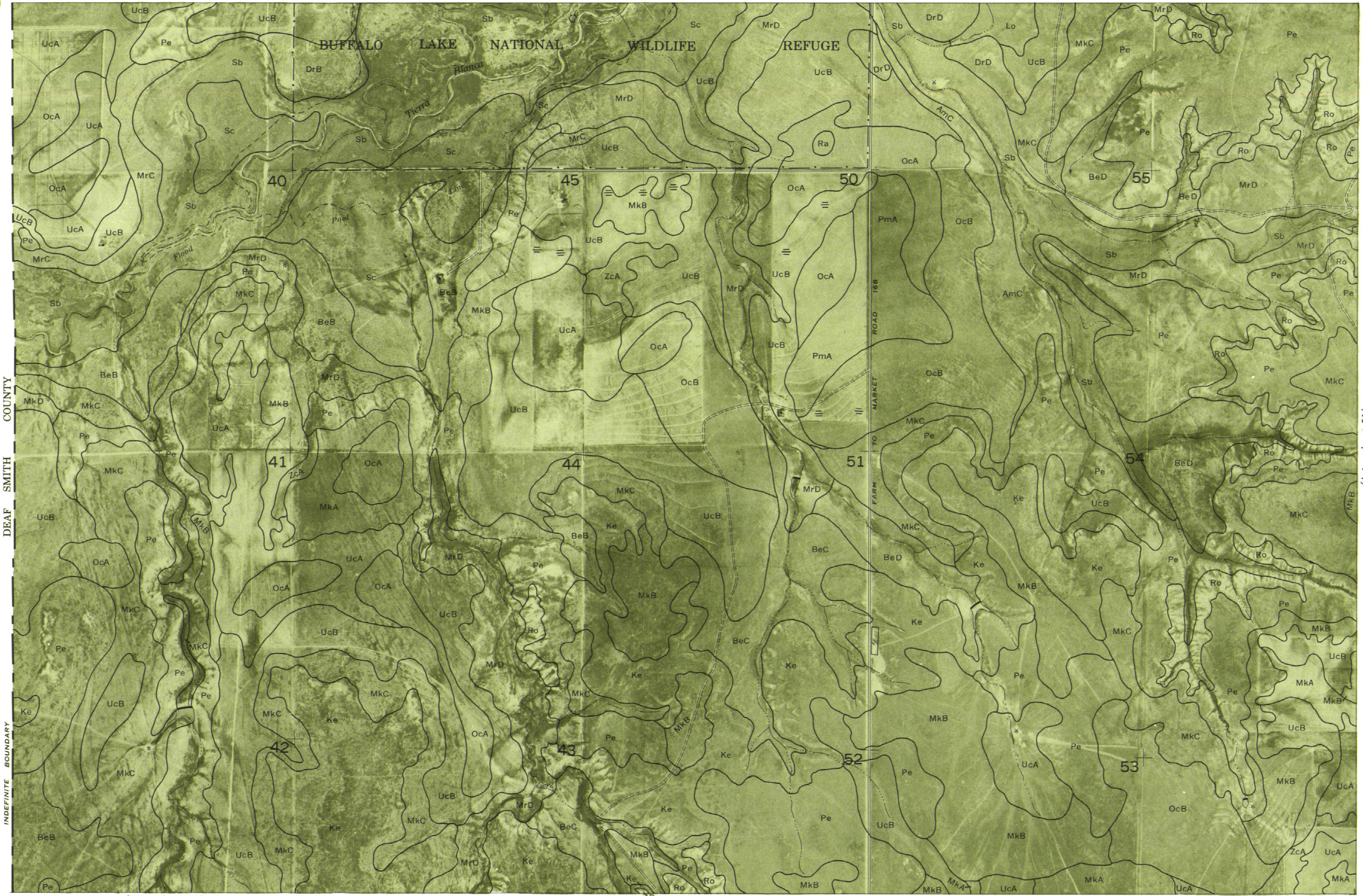
0 5000 Feet

N

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

50

(Joins sheet 43)



(Joins sheet 51)

(Joins sheet 56)

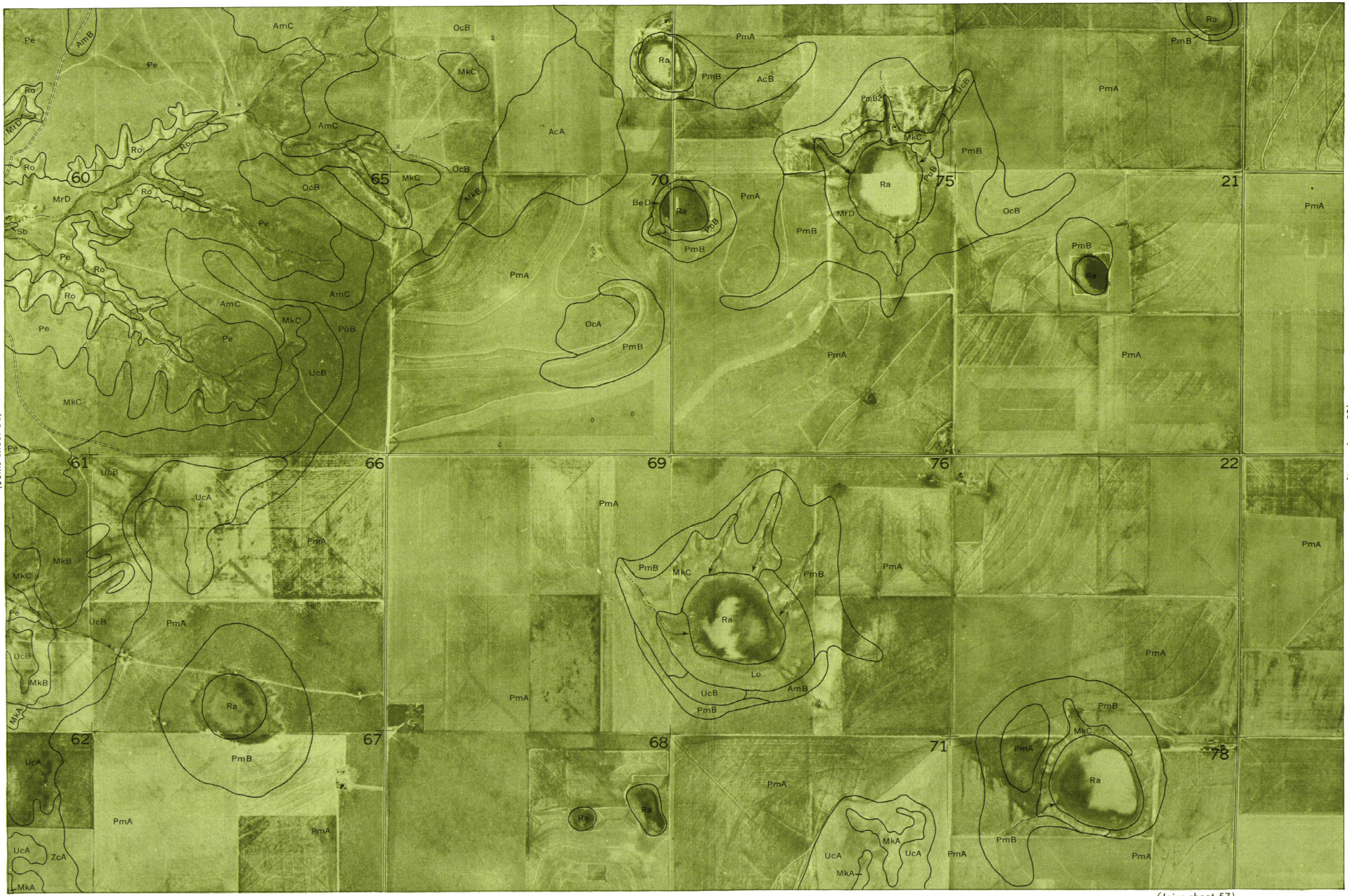
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 50

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station. Land division corners are positioned on this map.

RANDALL COUNTY, TEXAS — SHEET NUMBER 51

(Joins sheet 44)



(Joins sheet 50)

(Joins sheet 52)

(Joins sheet 57)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station
Land division corners are approximately positioned on this map.

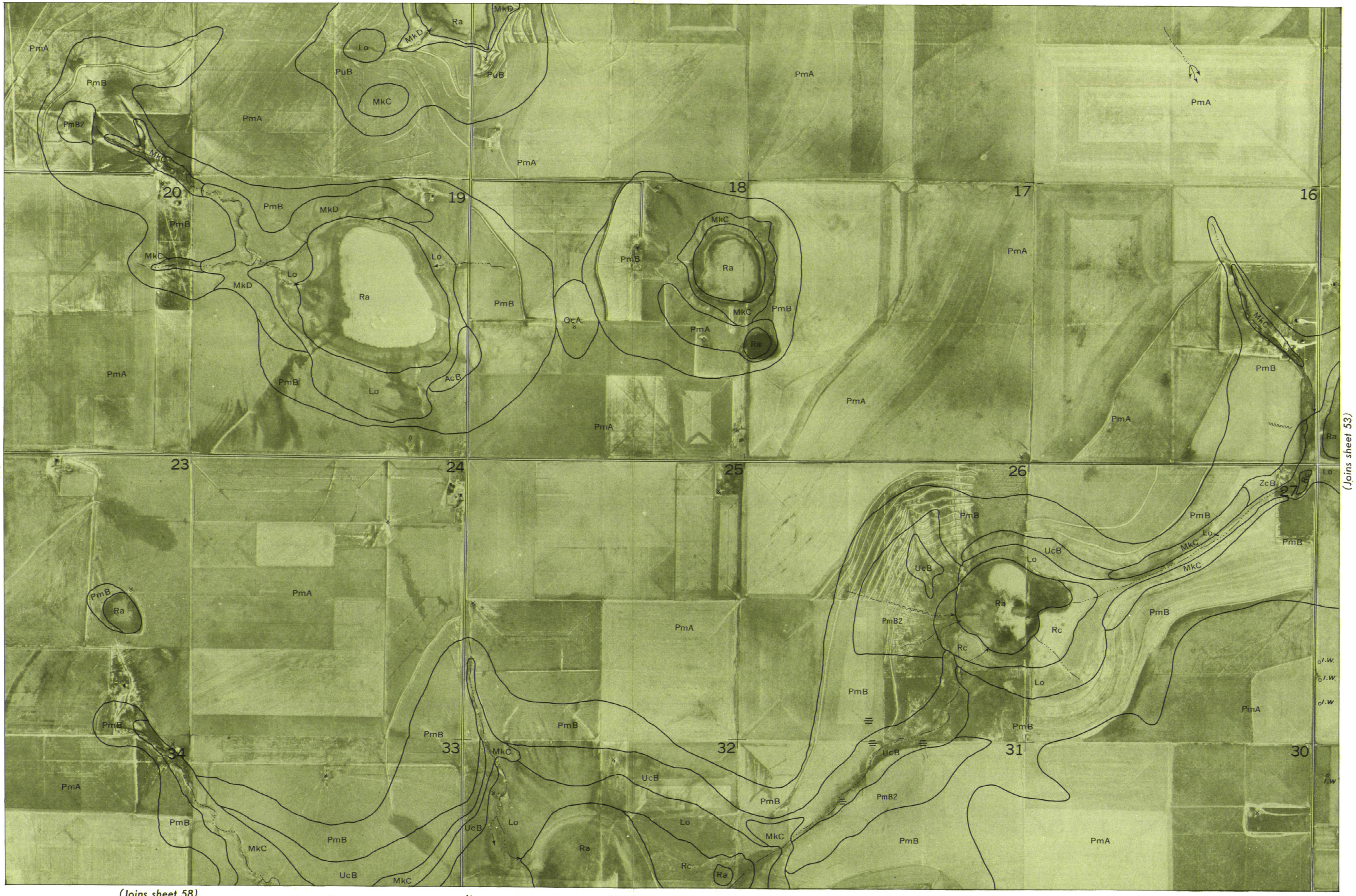
RANDALL COUNTY, TEXAS NO. 51

RANDALL COUNTY, TEXAS — SHEET NUMBER 52

(Joins sheet 45)

N

(Joins sheet 51)



(Joins sheet 53)

(Joins sheet 58)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 52

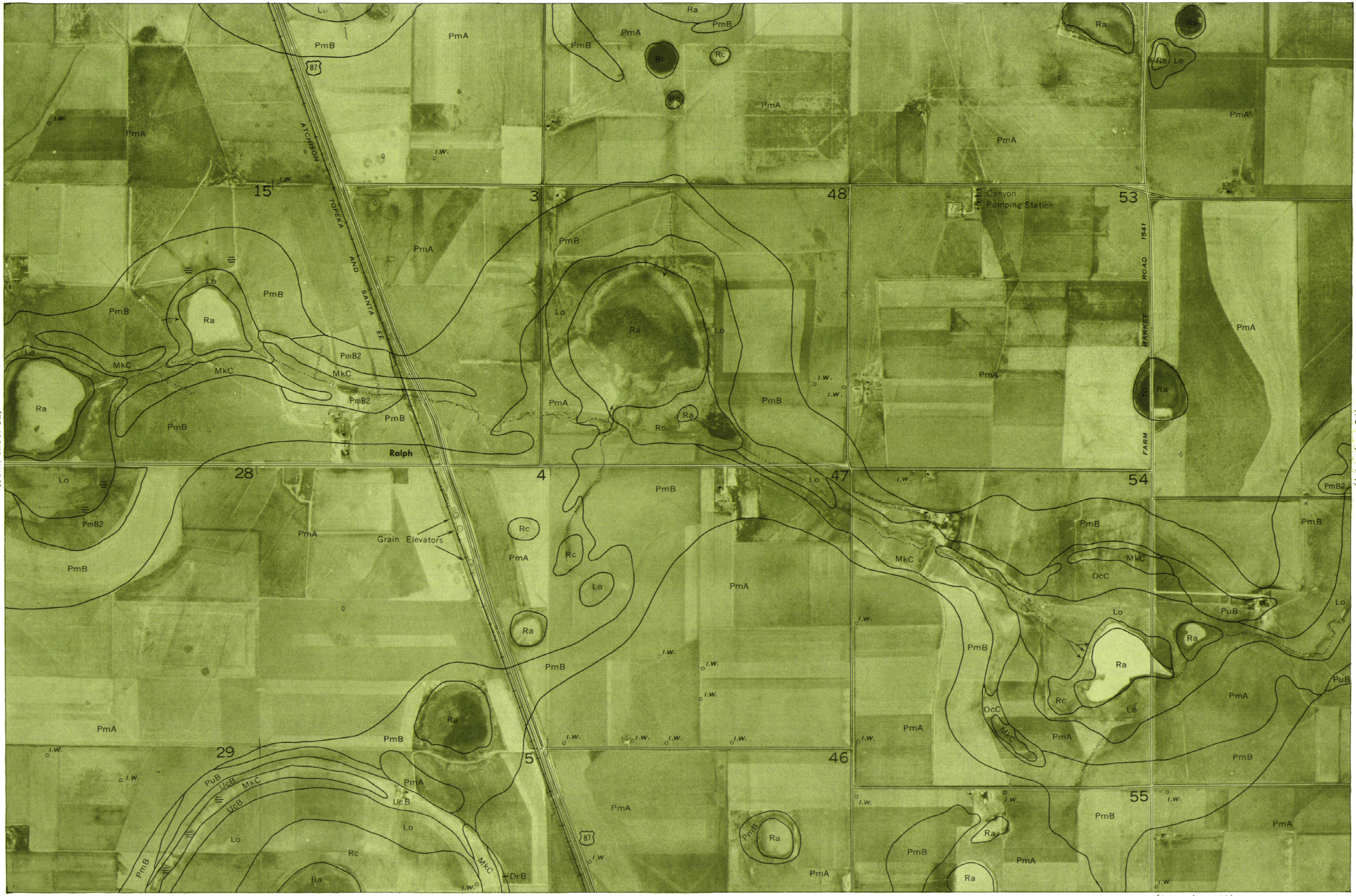
This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

(Joins sheet 46)

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 53

(Joins sheet 52)

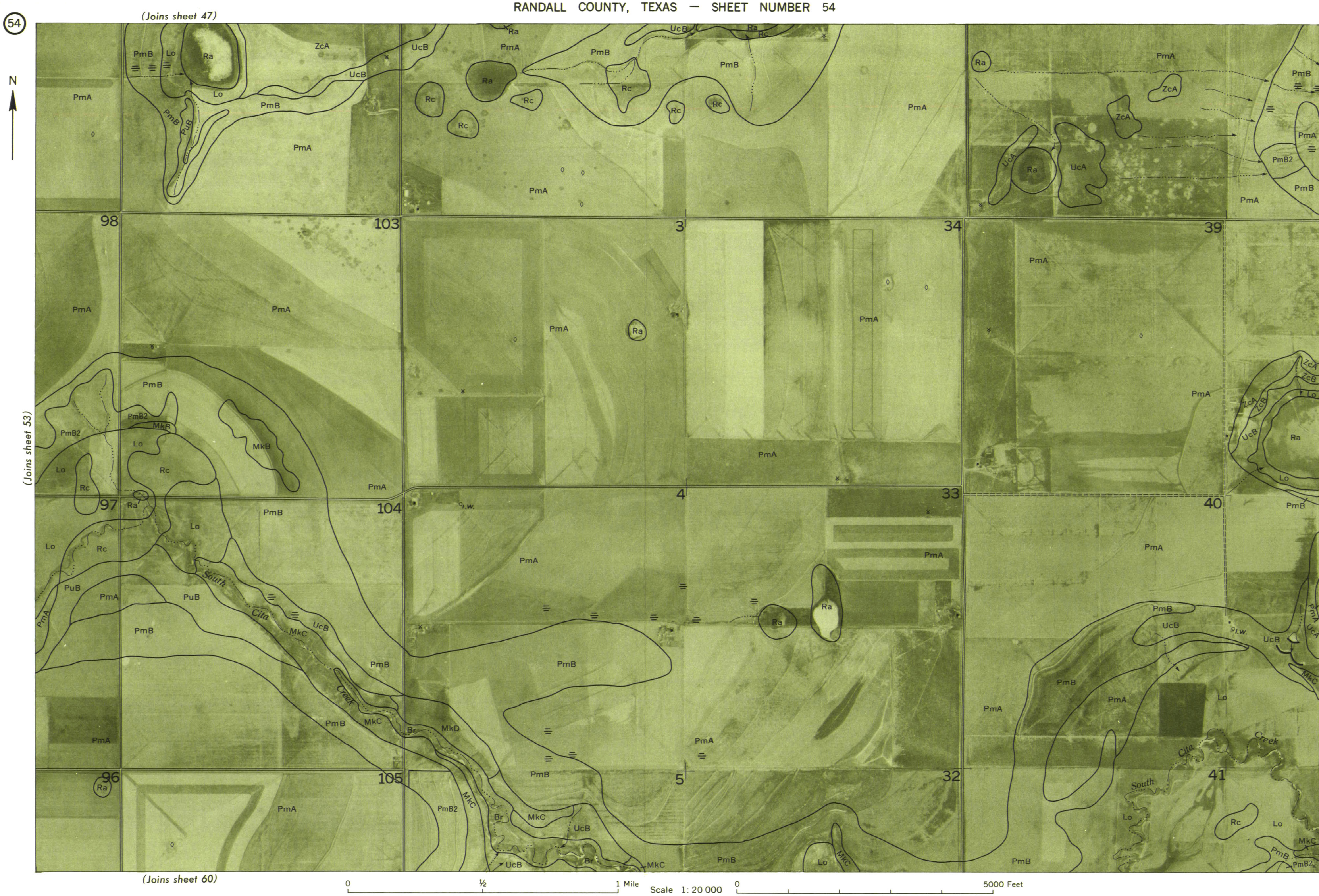


(Joins sheet 54)

N

(Joins sheet 59)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet



RANDALL COUNTY, TEXAS NO. 54

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

(Joins sheet 48)

55

N

(Joins sheet 54)

(Joins sheet 49)

(Joins sheet 61)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 55

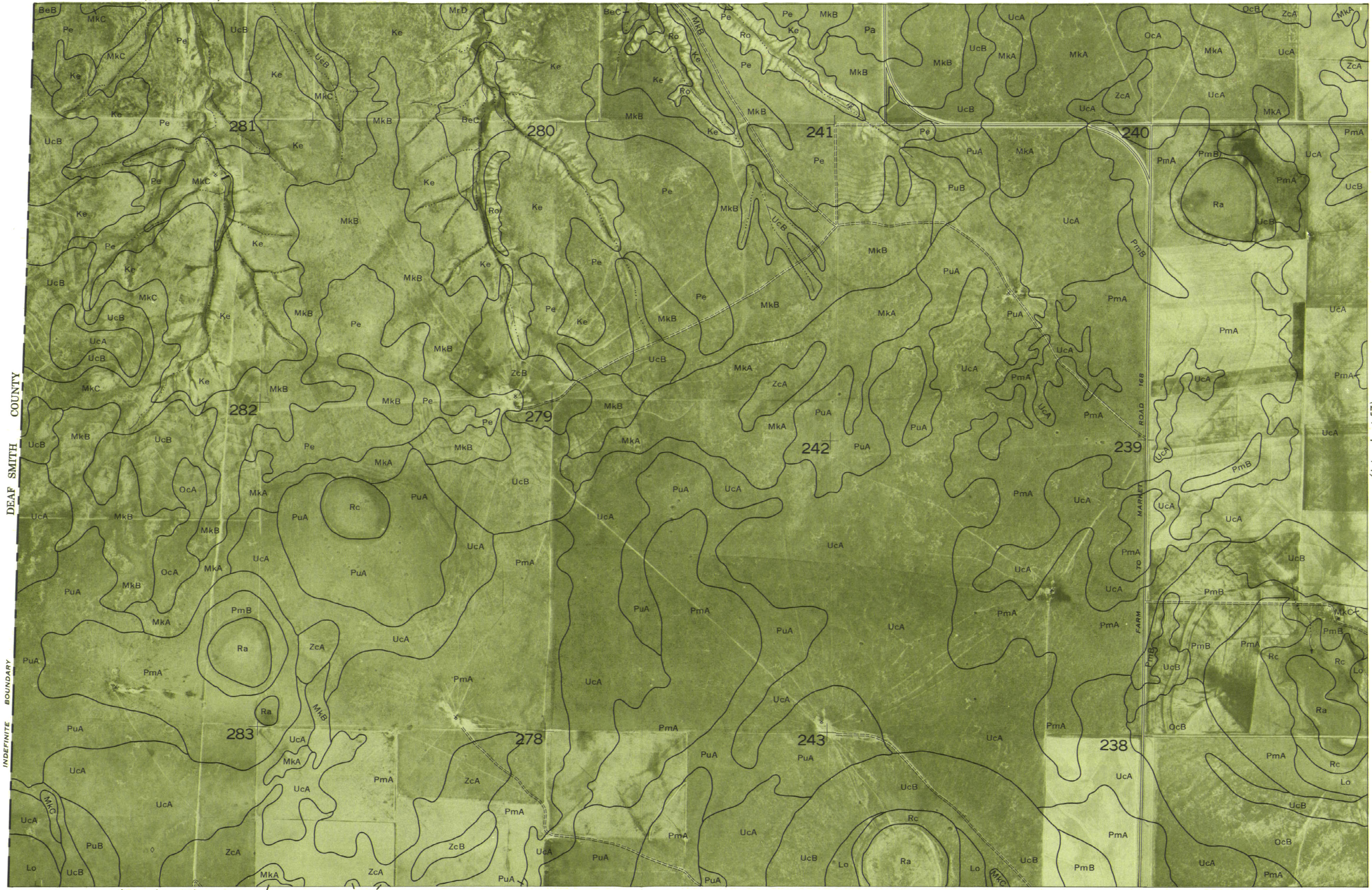
This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station
Land division corners are approximately positioned on this map.

56

RANDALL COUNTY, TEXAS — SHEET NUMBER 56

(Joins sheet 50)

N



(Joins sheet 57)

(Joins sheet 63)

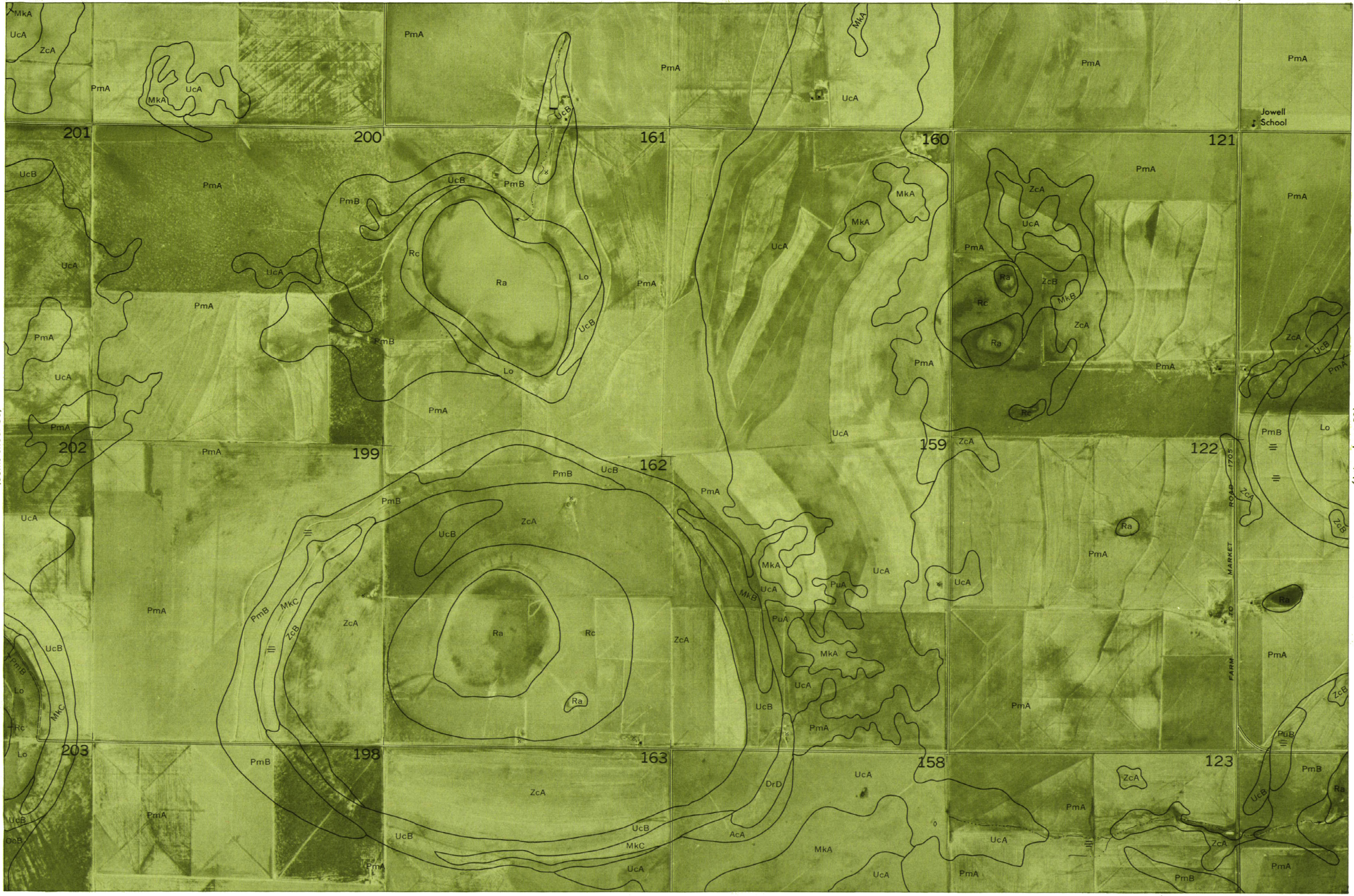
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS — SHEET NUMBER 57

(57)

(Joins sheet 51)



(Joins sheet 56)

(Joins sheet 58)

(Joins sheet 64)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station. Land division corners are approximately positioned on this map.

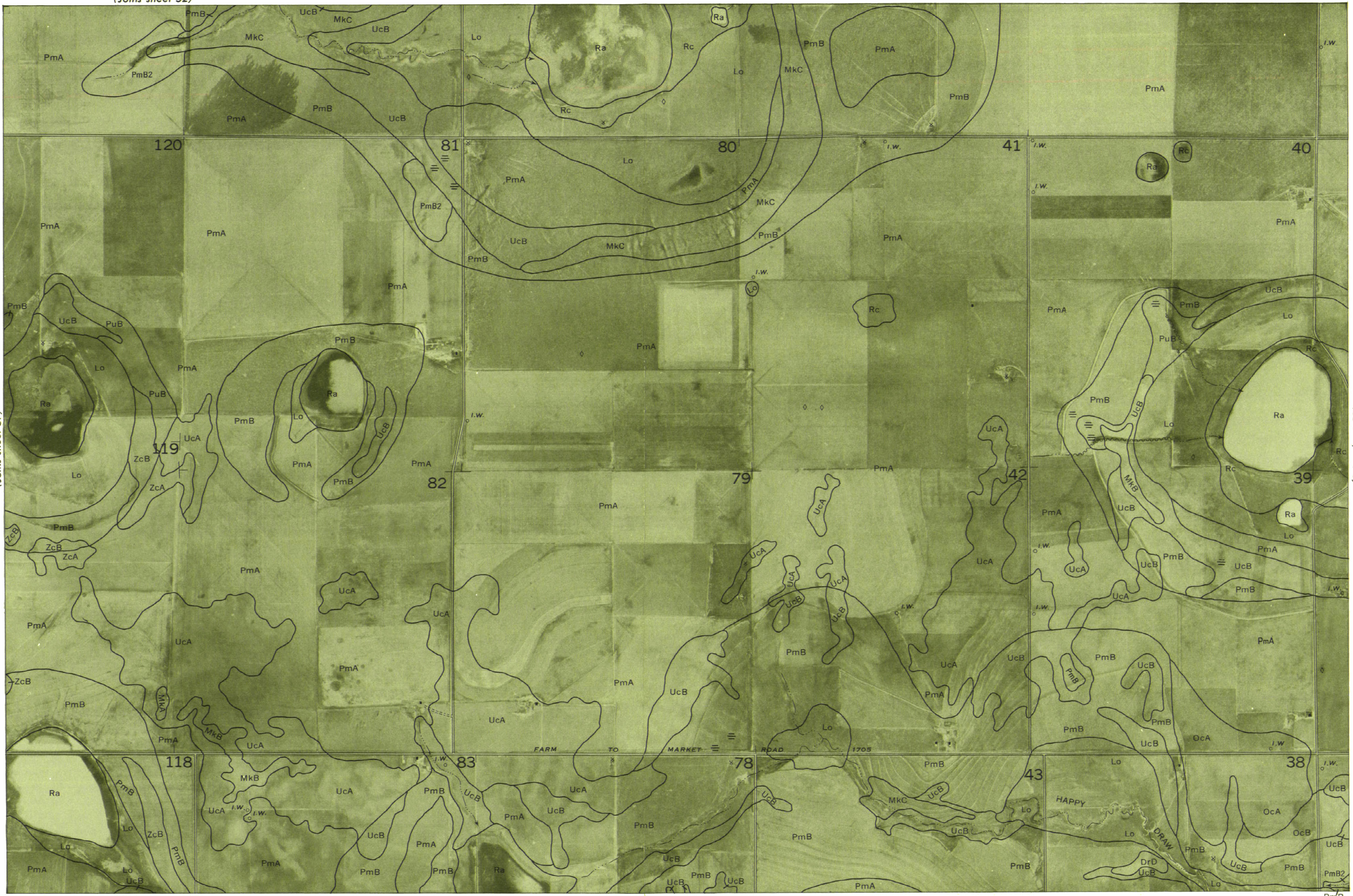
RANDALL COUNTY, TEXAS NO. 57

58

(Joins sheet 52)

N

(Joins sheet 57)



(Joins sheet 59)

(Joins sheet 65)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 58

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS — SHEET NUMBER 59

(Joins sheet 53)

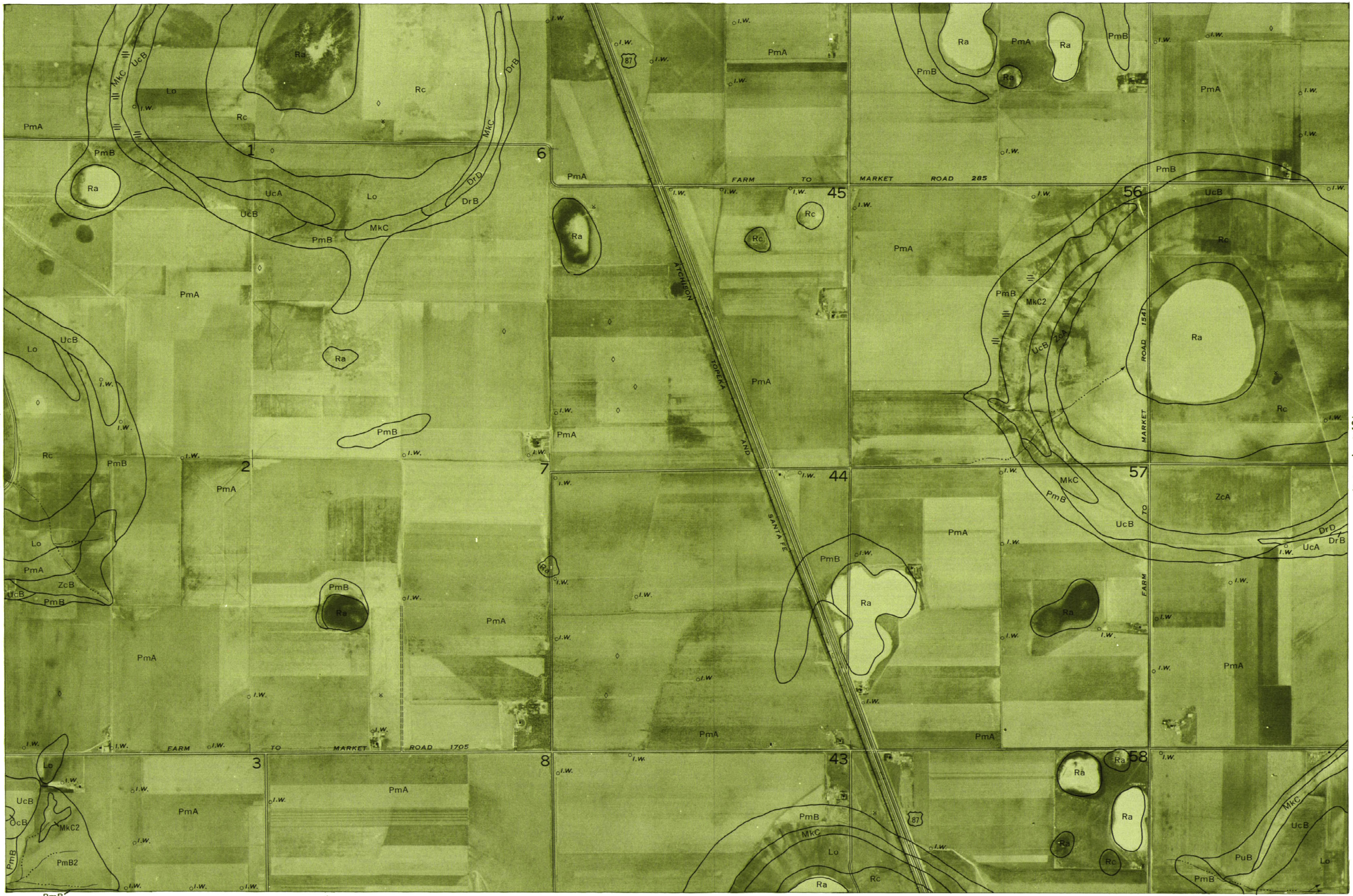
59

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station

Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 59

(Joins sheet 58)



(Joins sheet 60)

(Joins sheet 66)

0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

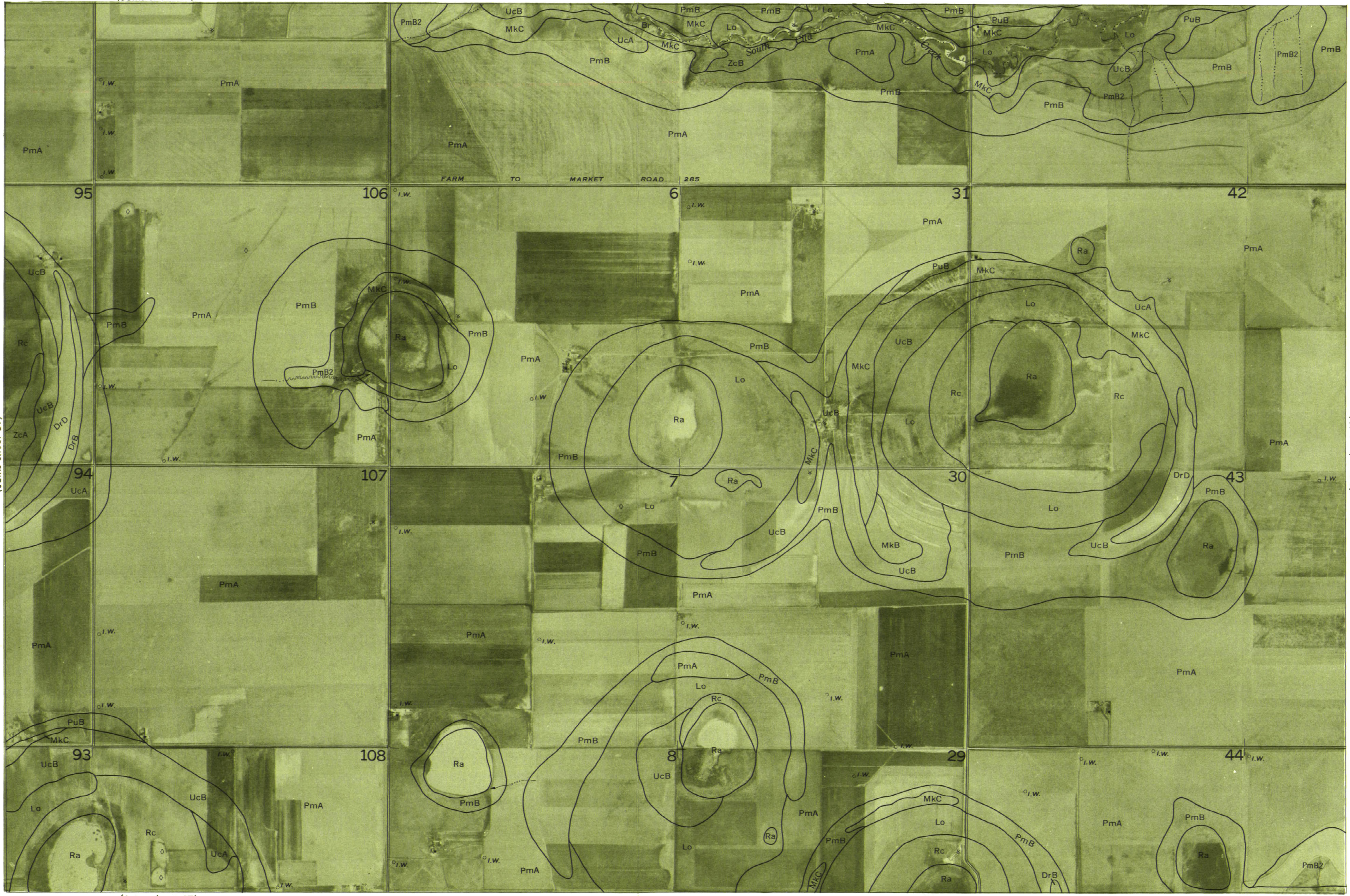
RANDALL COUNTY, TEXAS — SHEET NUMBER 60

60

(Joins sheet 54)

N

(Joins sheet 59)



(Joins sheet 61)

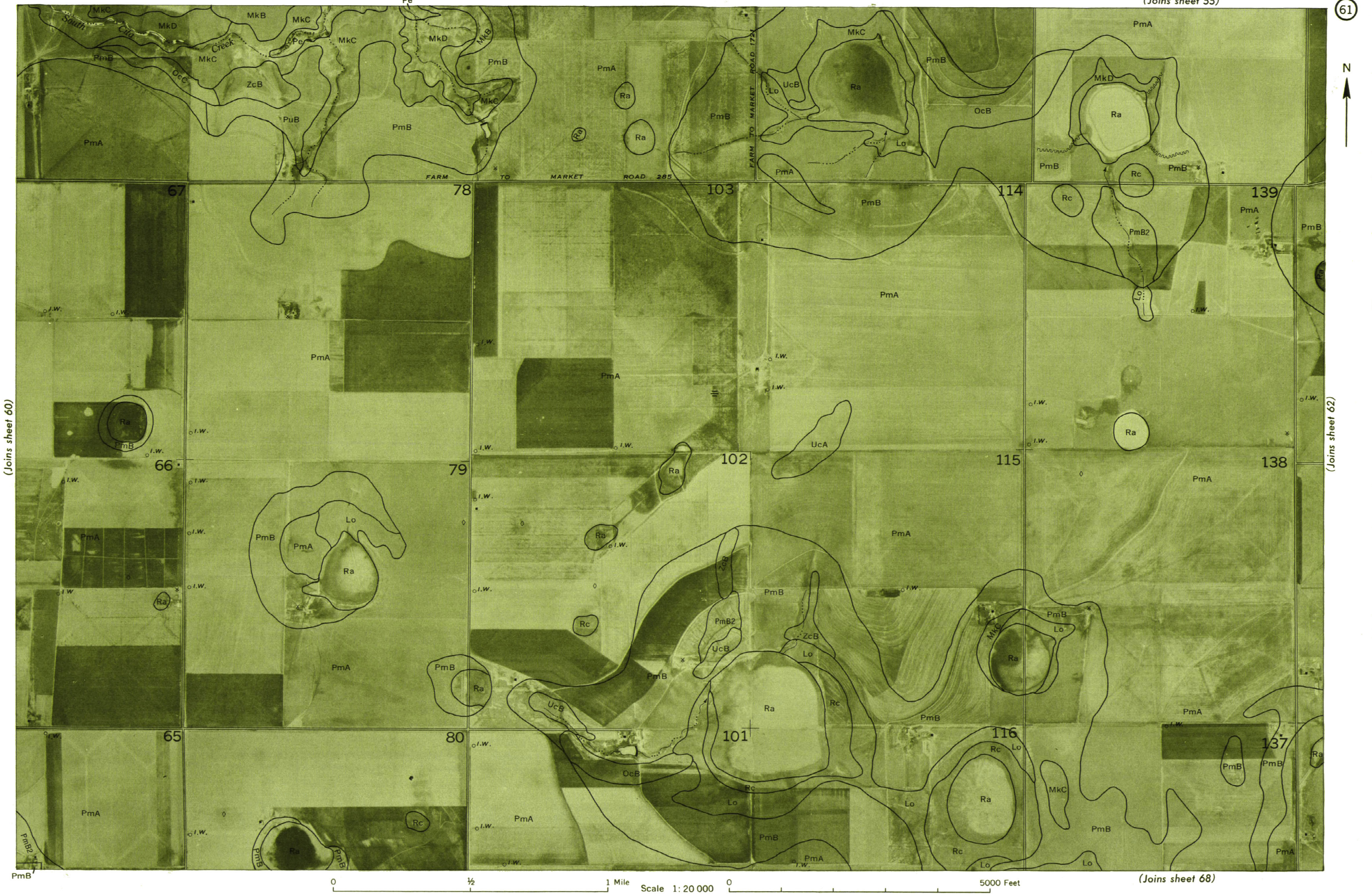
(Joins sheet 67)

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 60

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.



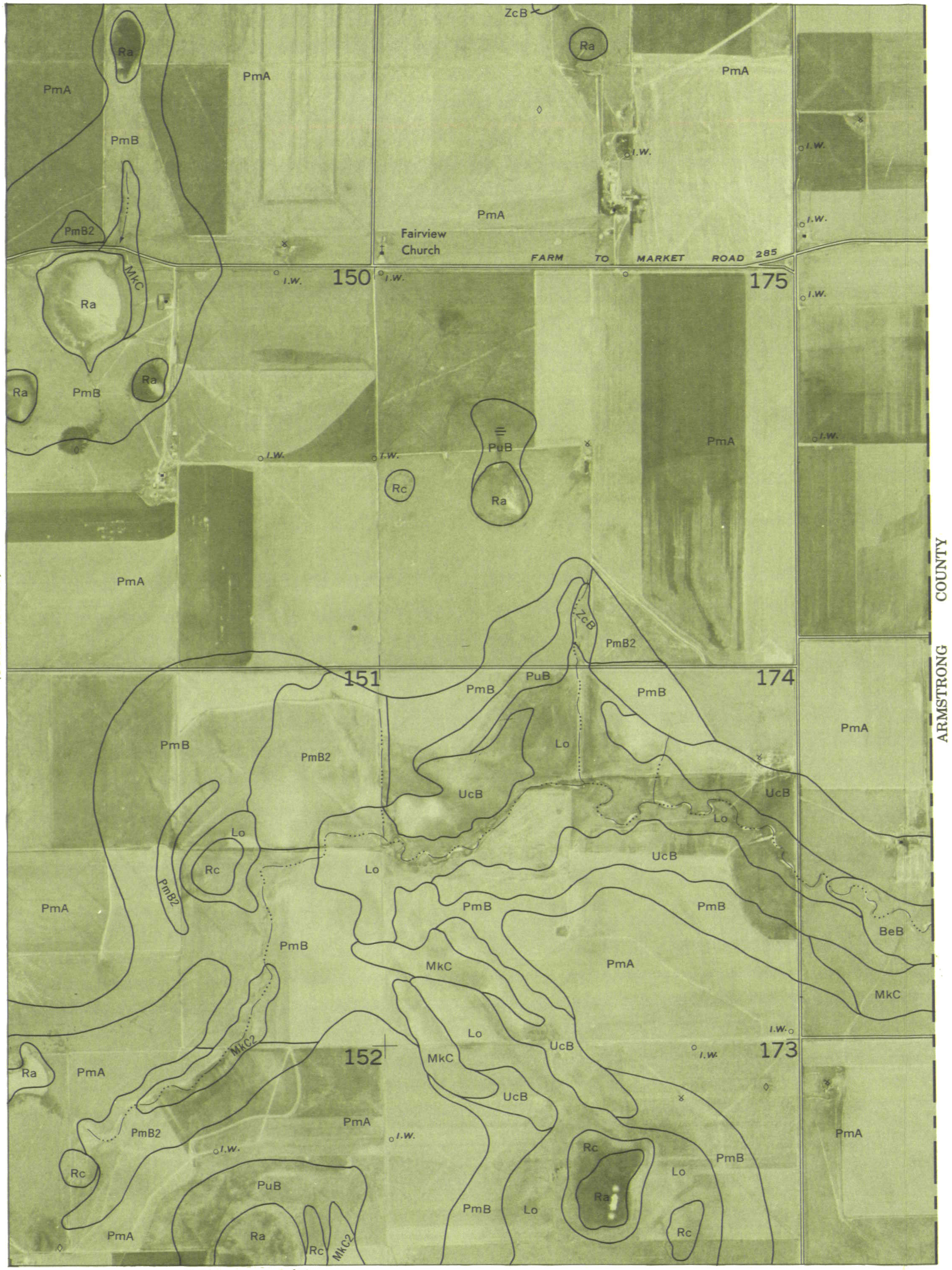
This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 61

62

(Joins sheet 49)

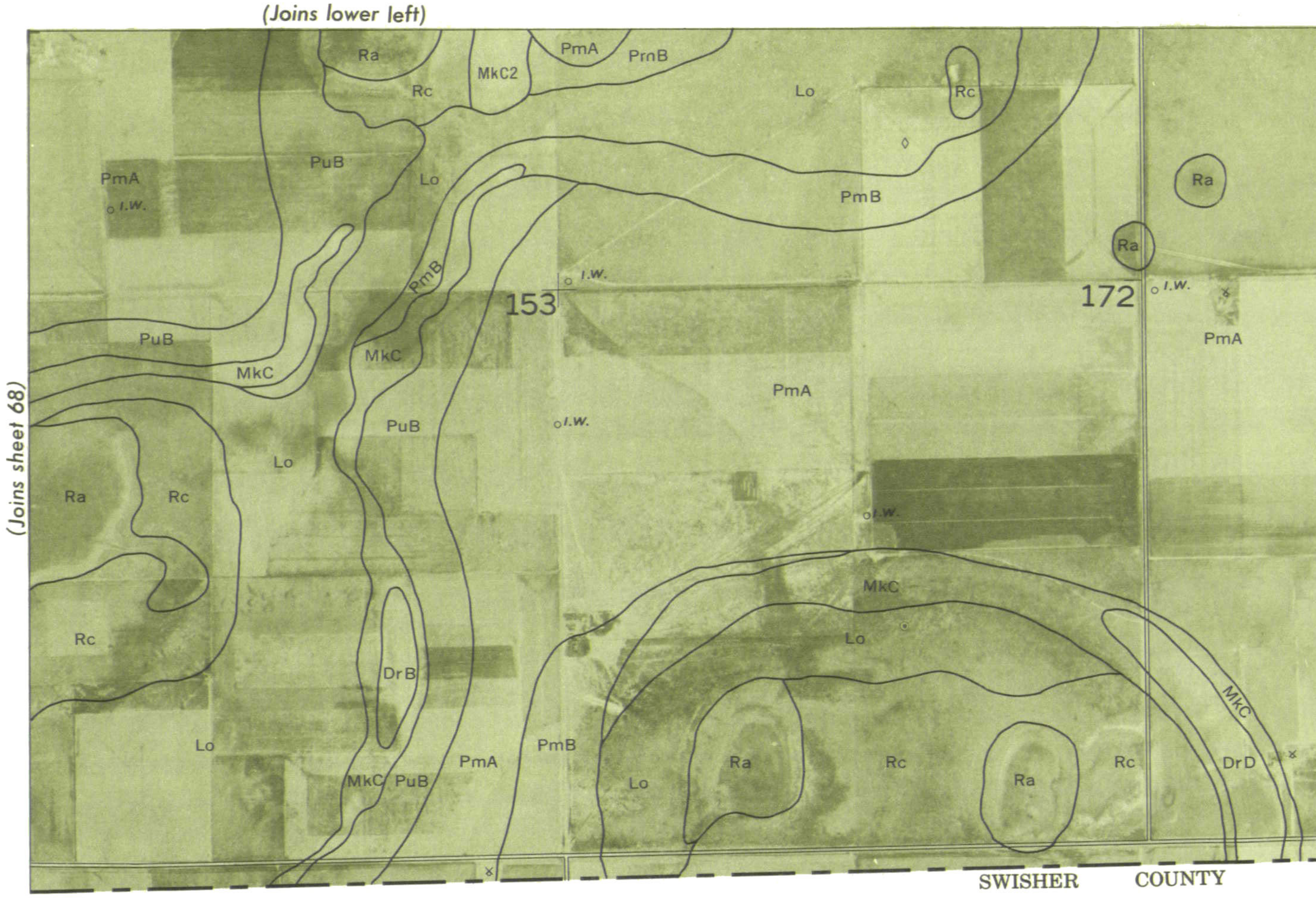
(Joins sheet 61)



(Joins upper right)

(Joins lower left)

(Joins sheet 68)



0 ½ 1 Mile

Scale 1: 20 000

0 5000 Feet

RANDALL COUNTY, TEXAS NO. 62

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

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Land division corners are approximately positioned on this map.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

64

(Joins sheet 57)

(Joins sheet 63)

(Joins sheet 65)

CASTRO COUNTY

RANDALL COUNTY, TEXAS NO. 64

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

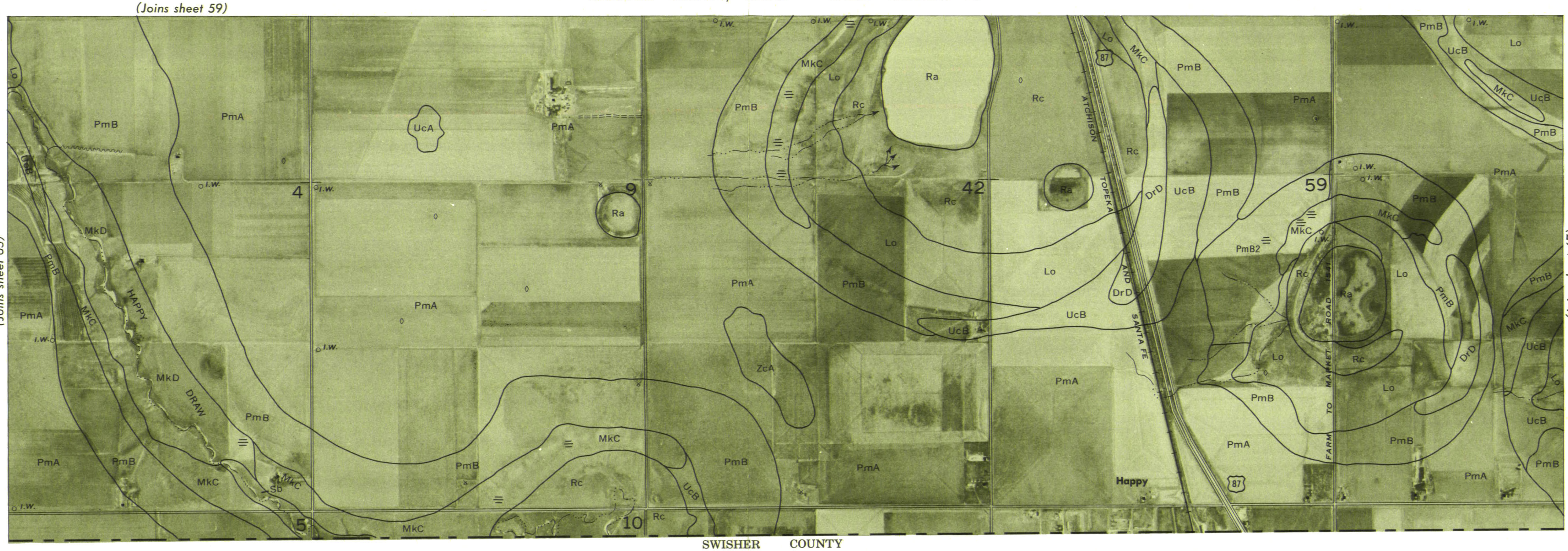
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 65

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

66



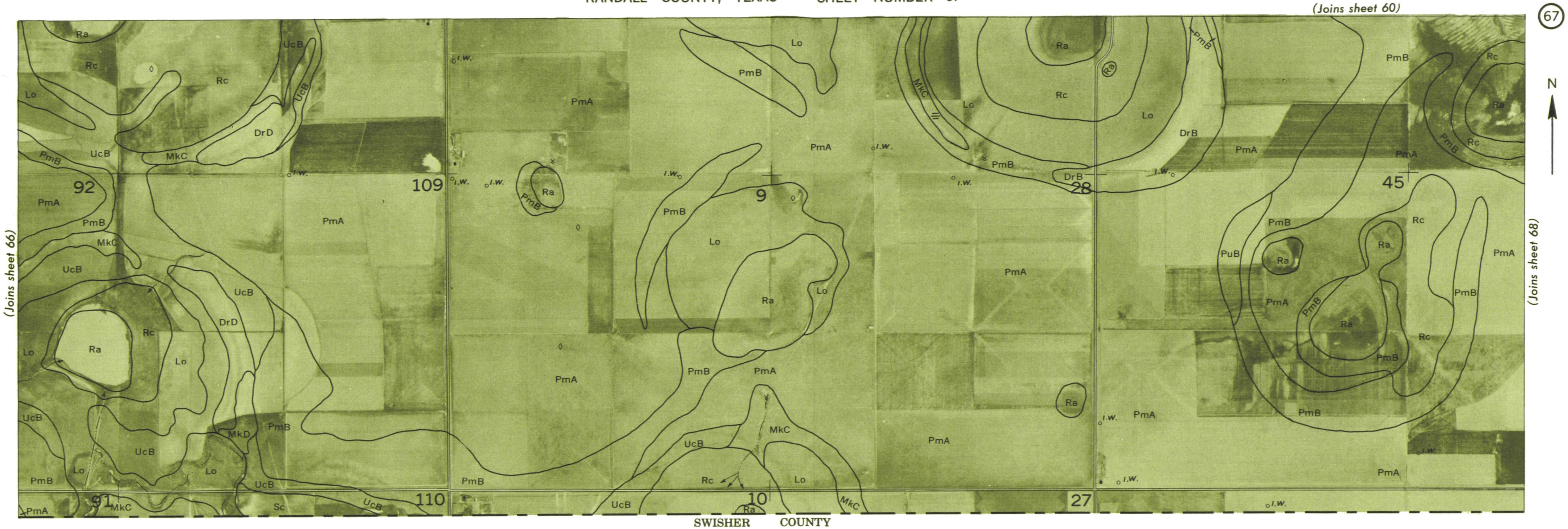
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS NO. 66

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS — SHEET NUMBER 67



This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station
Land division corners are approximately positioned on this map.

RANDALL COUNTY, TEXAS NO. 67

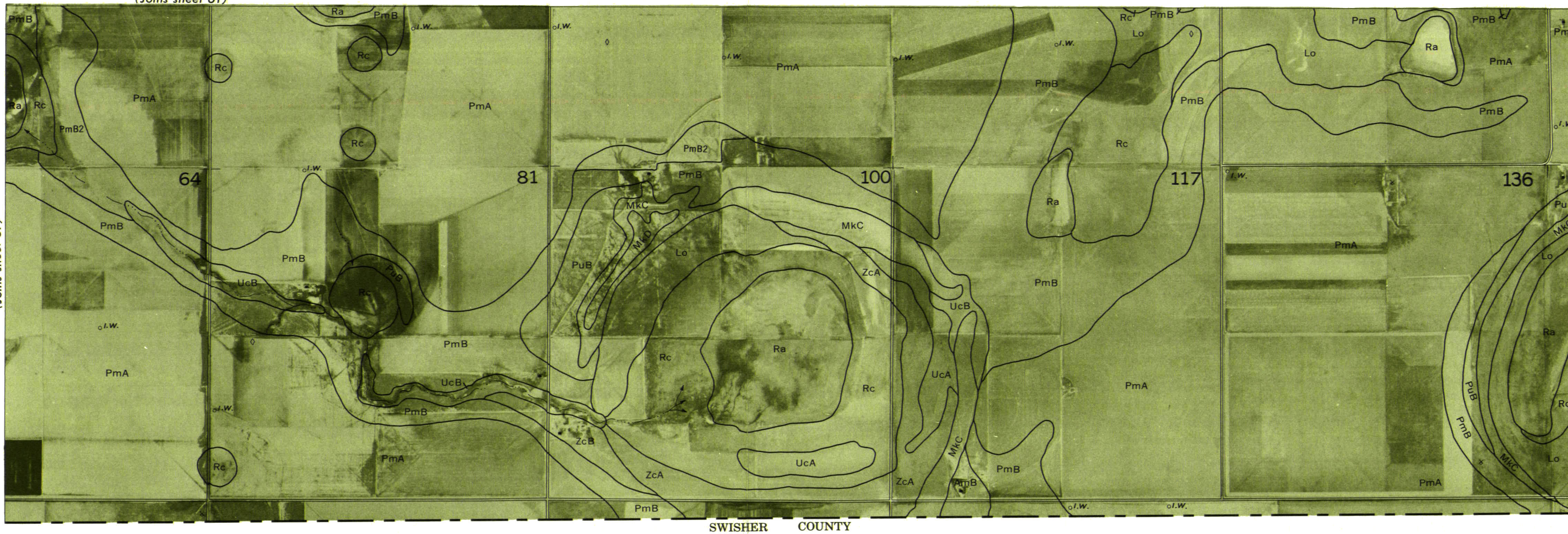
0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet

RANDALL COUNTY, TEXAS — SHEET NUMBER 68

68

(Joins sheet 61)

(Joins sheet 67)



(Joins inset, sheet 62)

RANDALL COUNTY, TEXAS NO. 68

This map is one of a set compiled in 1967 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Texas Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

0 ½ 1 Mile Scale 1: 20 000 0 5000 Feet